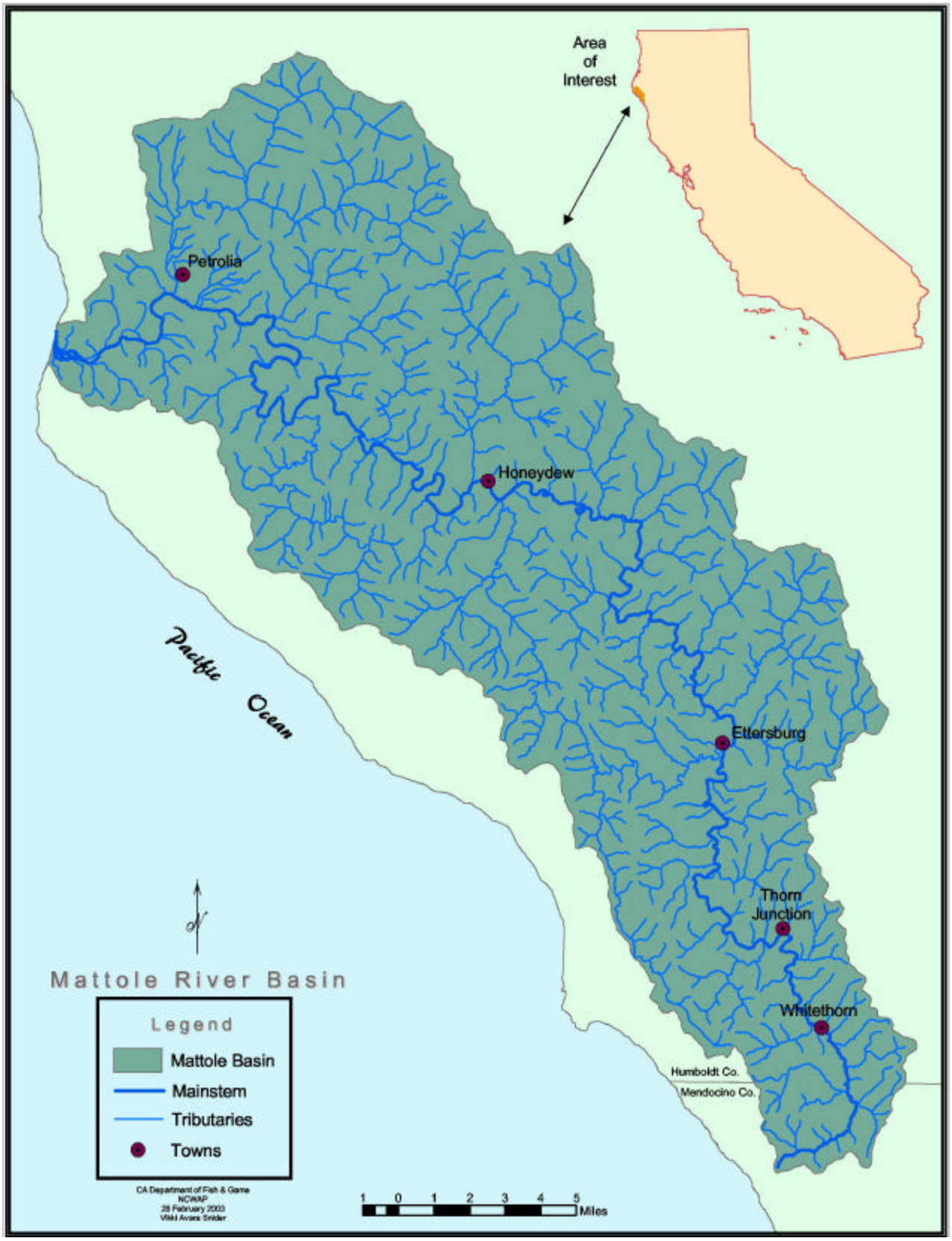
Mattole Basin Assessment Implementation Summary



Mattole Assessment Team

Fisheries:

Scott Downie - Team Leader	California Department of Fish and Game
Beatrijs deWaard	Pacific States Marine Fisheries Commission
Gary Peterson	Mattole Salmon Group

Forestry and Land Use:

Fay Yee	California Department of Forestry and Fire Protection
Jennifer Miller	California Department of Forestry and Fire Protection

Water Quality:

Elmer Dudik	North Coast Regional Water Quality Control Board
John Clements	Department of Water Resources

Geology:

Clifton Davenport, CEG	Department of Conservation/California Geological Survey
Marc Delattre, CEG	Department of Conservation/California Geological Survey
Dale Dell'Osso, CEG	Department of Conservation/California Geological Survey
Jim Falls, CEG	Department of Conservation/California Geological Survey
Jennifer Thornburg, CEG	Department of Conservation/California Geological Survey

Fluvial Geomorphology:

John Curless, CEG	Department of Conservation/California Geological Survey
Wayne Haydon, CEG	Department of Conservation/California Geological Survey

Geographic Information System, Data Management, EMDS, and KRIS:

Vikki Avara-Snider	Pacific States Marine Fisheries Commission
Steve Cannata	California Department of Fish and Game
Chris Fischer	California Department of Forestry and Fire Protection
Kevin Hunting	California Department of Fish and Game
Chris Keithley	California Department of Forestry and Fire Protection
Lisa Ohara	Department of Conservation/California Geological Survey
Gary Reedy	Institute for Fishery Resources
Peter Roffers	Department of Conservation/California Geological Survey
Kira Sorensen	Department of Conservation/California Geological Survey
Jennifer Terwilliger	California Department of Fish and Game
Richard Walker, PhD.	California Department of Forestry and Fire Protection

Research and Documents Production:

David Snider	California Department of Fish and Game
Shannon Stewart	California Department of Fish and Game

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Mattole Basin Assessment Implementation Summary

Preface to this Summary

This summary is intended to present the 2003 Mattole Basin Assessment Report's findings and recommendations in as concise a manner as possible. Therefore, the assessment's goals, methods, and analytic tools and systems are only briefly discussed here. Likewise the basin's contextual background, history, and the conditions of its geology, hydrology, vegetation, stream systems, water quality, and land uses are also summarized. To explore those assessment details, and explain the development of these findings and recommendations, the reader is directed to the complete report and its several appendices.

Mattole Basin Assessment Report Structure and Usage Guide

The Mattole Assessment Report has seven main sections:

- Executive Summary;
- Program Introduction and Overview;
- Assessment Strategy and General Methods;
- Mattole Basin Profile and Synthesis;
- Subbasin Profiles and Syntheses;
  - Estuary
  - Northern Subbasin
  - Eastern Subbasin
  - Southern Subbasin
  - Western Subbasin
- Mattole Basin in the Regional Context;
- Appendices.

The order of the five watershed profile sections are all the same:

- Disciplinary findings and analyses;
- Listing of issues raised during the assessment;
- Integrated Analysis;
- Ecological Management Decision Support (EMDS) calculations (limiting factors analysis);
- Tributary recommendations analysis and results;
- Refugia rating analysis and results;
- Assessment focus areas and issues investigation results;
- Responses to the six assessment questions including recommendations (see bolded section below);
- Conclusions.

There are five disciplinary appendices to the Mattole Assessment Report:

- Appendix A: Geology;
- Appendix B: Land use and Vegetation;
- Appendix C: EMDS System;
- Appendix D: Hydrology;
- Appendix E: Water Quality;
- Appendix F: Stream Habitat and Fisheries.

Of interest to many readers are the recommendations associated with specific locations in the basin with which they are familiar or in which they have ownership. In the report, basin and subbasin maps are provided at the beginning of each of the five profile sections to help them locate points of interest. By referring to the general tributary refugia rating system results, and the GIS image on pages 156 – 158, surveyed streams can be easily determined and their refugia ratings observed. Discussion concerning the development of the refugia rating system is in the Methods Section beginning on page 68, and also in Appendix F.

Tributary habitat improvement recommendations are summarized on pages 151 – 155. Specific recommendations for the tributaries are provided in the appropriate subbasin sections (e.g., pages 259 – 262 for the Northern Subbasin; see the Table of Contents for others). Following the tributary recommendation tables and discussion, the six guiding assessment questions are answered. In the Mattole Profile section the question responses are on pages 159 - 165; the last question's response is closely related to the earlier recommendation sections, but also presents other potential watershed improvement activities. Question six responses are also presented in this summary. They are organized in five general categories:

- Flow and water quality improvement activities
- Erosion and sediment delivery reduction activities
- Riparian and habitat improvement activities
- Supplemental fish rescue and rearing activities
- Education, research, and monitoring activities

The organization of the Assessment Report's findings, conclusions, and recommendations sections are intended to allow the reader to compare EMDS results, refugia ratings, limiting factors, and the resultant improvement recommendations for logic and appropriateness. Investigators are encouraged to read back through the IA Analysis, disciplinary findings, etc., and to the detail contained in the appendices. This should provide a clear understanding of the assessment results and help validate the assessment.

California's Large Scale Watershed Assessment Program

In 2000, the California Legislature established its first large scale watershed assessment program. The North Coast Watershed Assessment Program (NCWAP) was developed in 2000 – 2003 by a multi-disciplinary team composed of staff from the Resources Agency and the departments of Fish and Game (CDFG), Forestry and Fire Protection (CDF), Conservation/California Geologic Survey (DOC/CGS), and Water Resources (DWR), in conjunction with the North Coast Regional Water Quality Control Board (NCRWQCB) and State Water Resources Control Board. The program intended to provide a consistent body of information on North Coast watersheds for use by landowners, stakeholders, and collaborative watershed groups. Due to General Fund reductions in 2003, the program was reduced, and became part of CDFG as the Coastal Watershed Planning and Assessment Program (CWPAP). Regardless, the resultant assessment products should facilitate actions to create positive change in watershed conditions in the North Coast. The program was guided by six logical assessment questions at basin, subbasin, and tributary scales:

- **What are the history and trends of the size, distribution, and relative health and diversity of salmonid populations?**
- **What are the current salmonid habitat conditions? How do these conditions compare to desired conditions?**
- **What are the past and present relationships of geologic, vegetative, and fluvial processes to stream habitat conditions?**
- **How has land use affected these natural processes?**
- **Based upon these conditions, trends, and relationships, are there elements that could be considered to be limiting factors for salmon and steelhead production?**
- **What watershed and habitat improvement activities would most likely lead toward more desirable conditions in a timely, cost effective manner?**

To help answer these questions, the basin assessment has been designed to meet these strategic program goals:

- Organize and provide existing information and develop limited baseline data to help evaluate the effectiveness of various resource protection programs over time;
- Provide assessment information to help focus watershed improvement programs, and assist landowners, local watershed groups, and individuals to develop successful projects. This will help guide support programs, like CDFG's Fishery Restoration Grants Program, toward those watersheds and project types that can efficiently and effectively improve freshwater habitat and lead to improved salmonid populations;

- Provide assessment information to help focus cooperative interagency, nonprofit, and private sector approaches to protect the best watersheds and streams through watershed stewardship, conservation easements, and other incentive programs;
- Provide assessment information to help landowners and agencies better implement laws that require specific assessments such as the State Forest Practice Act, Clean Water Act, and State Lake and Streambed Alteration Agreements.

General Assessment Approach

Each of the assessment program's participating departments developed data collection and analysis methods used in their basin assessments. They also developed a number of tools for interdisciplinary synthesis of collected information. These included models, maps, and matrices for integrating information on basin, subbasin, and stream reach scales to explore linkages among watershed processes, conditions, and land use. These tools provided a framework for identifying watershed refugia areas and factors limiting salmonid productivity, as well as providing a basis for understanding the potential for cumulative impacts from natural and man caused disturbances. This information provided guidance for developing restoration, management, and conservation recommendations.
The steps in the large scale assessment included:

- Form multi-disciplinary team. In order to assess watershed conditions and processes, several specialists were needed and included: geologists, fluvial geo-morphologists, foresters, hydrologists, water quality analysts, biologists, habitat specialists, planners, and most importantly, the landowners and residents of the assessment area;
- Conduct scoping and outreach workshops. A series of meetings from Spring 2001 through Summer 2003 were held during the course of the Mattole assessment;
- Determine logical assessment scales. The Mattole assessment team subdivided the Mattole Basin into five subbasins for assessment and analyses purposes (Figure 1). These study areas included the Estuary, Northern, Eastern, Southern, and Western Subbasins. In general, each subbasin has somewhat unique attributes that are generally common to the several CalWater 2.2a Planning Watersheds (PW's) contained within a subbasin. These PW's are approximately 3,000-10,000 acres and are used as planning and evaluation units for projects such as Timber Harvest Plans (THP) submitted to CDF. Common subbasin attributes considered include geology, landslide propensity, vegetation, climate, land use, streams, fisheries, towns and communities, access corridors, etc.
- Discover and organize existing data and information according to discipline. This information was used to form the basis of the disciplinary appendices to the assessment report;
- Identify data gaps needed to develop the assessment. Working with limited time and resources constrained the amount of field work that was performed. Therefore, this item was restricted to collecting the most necessary field information needed to test extant information;
- Collect limited field data. Limited stream and fishery surveys were performed. Foresters and geologists were able to check air photo analyses with field verification at several locations. Water quality samples were taken, and a new stream flow gage was installed at Ettersburg.
- Amass and analyze information. Assembled data were used to create the various discipline reports, which eventually become the Mattole Basin Reports' appendices. This information was interpreted and reported out in the Assessment Report as disciplinary findings in each chapter specific to the basin and subbasins;
- Conduct Integrated Analysis (IA). Through the use of a series of IA Tables the disciplinary information were related to one another. These tables begin with geologic conditions and processes operating on them. These processes include natural disturbances like precipitation, earthquakes, fires, floods, droughts, landslides, and vegetation history, as well as human caused processes associated with land use and development. These disturbance factors cause responses in riparian and stream channel conditions, water quality, which in turn affects fish and other biota. The IA Tables follow these processes (drivers) through the delivery process and help explain the conditions (responses) they cause. The IA process also helps identify watershed condition trends;

Figure 1. Mattole assessment subbasins and CalWater 2.2a Planning Watersheds.

- Conduct limiting factors analysis (LFA). The Ecological Management Decision Support system (EMDS) was used, along with expert analysis and local input, to evaluate factors at the tributary scale. These factors were rated to be either beneficial or restrictive to the well being of fisheries. The CDFG Restoration Manual (Flosi, et al. 1998), and other literature, provided habitat condition values to help set EMDS reference curves. Additionally, stream inventories on over fifty Mattole tributaries were used by DFG biologists to augment and check the EMDS results;

- Conduct refugia rating analysis. The assessment team created a worksheet for rating refugia at the tributary scale (see below, page 68). The worksheet has 21 condition factors rated on a sliding scale from high to low quality. The 21 factors are grouped into five categories: 1) stream condition; 2) riparian condition; 3) native salmonid status (presence); 4) present salmonid abundance; and 5) management impacts (disturbance impacts to terrain, vegetation, and the biologic community). The tributary ratings are determined by combining the results of air photo analyses, EMDS, and data in the CDFG tributary reports by a multi-disciplinary, team of expert analysts. Ratings of various factors are combined to determine an overall refugia rating on a scale from high to low quality. The tributary ratings are subsequently aggregated at the subbasin scale and expressed as a general estimate of subbasin refugia conditions. Factors with limited or missing data are noted and discussed in the comments section as needed. In most cases there are data limitations on one to three factors. A discussion of the rating system is at the end of this summary;
- Develop conclusions and recommendations. Recommendation tables for watershed and stream improvement activities were developed at the tributary scale based upon stream inventory information, air photo analysis, field verification samples, workshop inputs, etc. From these sources improvement recommendations were made. They are presented at the end of each Profile chapter as answers to the sixth assessment guiding question;
- Produce and distribute the assessment documents. The CDFG component of the assessment team has been charged with follow up activities to the assessment. Their role is to facilitate implementation of the assessment's improvement recommendations and coordinate with the Fishery Restoration Grant Program and other sources of technical and financial assistance to landowners and interested groups and individuals;
- Update and maintain the reports in an adaptive manner. Watersheds and streams are dynamic places and change is constantly occurring in them. As new and better information becomes available, disturbances continue, and improvements take place, the document must be adapted to the changing environment or become dated. CDFG is again charged with working with landowners and interested groups and individuals to maintain and correct the assessment information to be as accurate and current as possible;
- Facilitate monitoring of conditions. CDFG is developing a monitoring program and will facilitate adopting it in the Mattole and other assessed watersheds.

Mattole Basin Profile

The Mattole Basin encompasses approximately 296 square miles of Northern California's Coast Range. Although nearly three percent of the Mattole's headwaters are in Mendocino County; the vast majority of the basin is within Humboldt County. The mainstem Mattole River is approximately 62 miles long, and receives water from over 74 tributary streams. There are approximately 545 perennial stream miles in the basin. The basin drains into the Pacific Ocean just south of Cape Mendocino. Elevation within the basin ranges from sea level at the estuary to 4,088 feet at Kings Peak.

The word Mattole meant "clear waters" in the language of the Athabaskan-speaking Mattole and Sinkyone Native Americans. Little is known about these Native Americans, for they were quickly displaced by settlers from the Eastern United States, who arrived in the early 1850s. Based upon the practices of other North Coast native peoples, it is presumed they utilized abundant, native salmon and steelhead resource for an important component of their sustenance.

The Mattole Basin has a Mediterranean climate characterized by cool wet winters with high runoff, and dry warm summers with greatly reduced flows. The basin receives one of the highest amounts of annual rainfall in California, averaging 81 inches. Along the coast, average air temperatures range from 46°F to 56°F. Further inland, annual air temperatures are much more varied, ranging from below freezing in winter to over 100° F in summer.

The Mattole Basin is located in a complex tectonic setting near the junction of three crustal plates. This region experiences a high level of seismic activity, and major earthquakes have occurred in intraplate areas as well as along well defined faults (Dengler et al. 1992). Bedrock underlying much of the basin has been tectonically broken and sheared making it relatively weak, easily weathered, and inherently susceptible to landsliding and erosion. Certain identifiable portions of the bedrock are more susceptible than others. The

unstable bedrock and soil conditions combined with heavy rainfall, high regional uplift rates, and very active seismicity produce widespread naturally-occurring landsliding with associated large volumes of sediment input to streams.

The current vegetation in the Mattole Basin is predominately forestland, although some localized areas are covered primarily by grasslands. Mixed conifer and hardwood forestland occupy 57% of the basin while hardwood forests occupy 17% and coniferous forests occupy another 8%. Annual grasslands occupy 15% of the basin. All other vegetation types occupy the remaining three percent of the basin. The Mattole Basin is unusual within the Northern California coast as having very little redwood forest present; this is thought to be primarily due to the King Range blocking the summer fog needed to stimulate the growth of redwoods.

The total Mattole Basin resident population for the year 2000 census was estimated to be about 1,200 people. Eighty-four percent of the basin is held and managed as private property. In 1941 air photos, the most widespread land use of the basin appears to have been grazing. Timber harvest operations began in earnest during the post World War II boom. By the late 1970s, timber harvesting had decreased to very low levels of production. Meanwhile, environmental awareness had increased among many residents of the Mattole Basin and the North Coast in general. Changes in policy concerning management of federal lands and the designation of the Northern Spotted Owl as federally threatened led to the designation of Bureau of Land Management (BLM) lands within the Mattole Basin as Late Succession Reserve lands that are not subject to timber harvest (BLM, Bear Creek Report 1995). The BLM ownership comprises 15% of the Mattole Basin so their management is very significant to the basin's resources.

Fishery resources of the Mattole Basin include fall-run Chinook salmon, coho salmon, summer-run steelhead trout, and winter-run steelhead trout. The salmon and steelhead trout have been traditionally important as food and recreation resources to local residents and visitors. Though anecdotal evidence provides a convincing case that historic anadromous salmonid runs in the Mattole Basin were large and there has been a sharp decline in the size of these runs since the mid 1950s, little quantitative historic data exist (BLM, 1996).

An estimate of Chinook salmon, coho salmon, and steelhead trout populations in the Mattole Basin was made by the United States Fish and Wildlife Service (USFWS) in 1960. Their estimates were based upon spawner surveys and interviews with sportsmen and local residents. From these two sources, Mattole Basin population estimates of 2,000 Chinook salmon, 5,000 coho salmon and 12,000 steelhead trout were made. Additionally, potential population estimates were projected based on the capacity of surveyed spawning reaches with suitable gravel. Potential populations of 7,900 pairs of Chinook salmon, 10,000 pairs of coho salmon and 10,000 pairs of steelhead trout were estimated.

Recent accounts from Mattole Basin anglers who fished in the 1945 – 1970 time period describe a fabled sport fishery where in good stream conditions a group of four or five anglers could expect to hook and release over a hundred fish, mostly steelhead, in a day of fishing (J. Clary, personal communication). Also, salmon poaching beneath the Petrolia Bridge, and elsewhere, provided a viable means of making a little Christmas money by selling fresh and smoked salmon as late as the 1960s (C. Wright, personal communication).

In 1965, the year following the second major flood event in ten years, the Department of Water Resources (DWR) speculated that there had been a significant reduction in the size of Mattole Basin anadromous fish runs. They felt this was a result of large increases in siltation and debris jams following land disturbance from intensive logging that started in 1950, coupled with the two major flood events. The fisheries began steady declines in the 1960s.

By the late 1970s, fish populations had collapsed to levels that alerted locals to their depressed condition. Local watershed groups, the BLM, various state agencies such as CDFG, and local landowners have worked on numerous restoration projects throughout the Mattole Basin. The Mattole Restoration Council (MRC) and the Mattole Salmon Group (MSG) have obtained contracts for work on such diverse areas of restoration as stream surveys, road assessment, re-vegetation, instream habitat improvement, fish rearing, public education, and monitoring.

Mattole Basin Profile Stream Reach Condition EMDS

The anadromous reach condition EMDS system calculates the conditions for salmonids in a stream reach based upon water temperature, riparian vegetation, stream flow, and in channel characteristics. Data used in the Reach EMDS come from CDFG Stream Inventories. Currently, data exist in the Mattole Basin to evaluate overall reach, canopy, in channel, pool quality, pool depth, pool shelter, and embeddedness conditions for salmonids. More details of how the EMDS functions are in Appendix C.

EMDS calculations and conclusions are pertinent only to surveyed streams and are based on conditions present at the time of individual survey. EMDS stream reach scores were weighted by stream length to obtain overall scores for subbasins and the entire Mattole Basin. The overall weighted average reach conditions on surveyed streams in the Mattole Basin as evaluated by the EMDS are described as "somewhat unsuitable" for salmonids (Table 1). Obviously, there is a great deal of variation among streams, subbasins, and among the several parameters evaluated. Suitable conditions exist for canopy in the Eastern, Southern, and Western Subbasins; and for pool quality and pool depth in the Southern Subbasin. Moderately unsuitable conditions exist for embeddedness in all four subbasins evaluated.

Table 1. EMDS anadromous reach condition model results for the Mattole Basin.

Subbasin	Reach	Water Temperature	Canopy	Stream Flow	In Channel	Pool Quality	Pool Depth	Pool Shelter	Embeddedness
Northern Subbasin	-	U	- -	U	-	- -	- -	- -	- -
Eastern Subbasin	-	U	+	U	-	- -	- -	- -	- -
Southern Subbasin	-	U	++	U	-	+	+	-	- -
Western Subbasin	-	U	+	U	-	-	-	-	- -
Mattole Basin	-	U	+	U	-	-	-	-	- -

Key: +++ Fully Suitable; ++ Moderately Suitable; + Somewhat Suitable; U Undetermined; - - - Fully Unsuitable; - - Moderately Unsuitable; - Somewhat Unsuitable

Mattole Basin Profile Summary of Tributary Recommendations

In order to compare the occurrence of recommendations between the four subbasins in the Mattole Basin, the three top ranking recommendations for each tributary were compiled. Each tributary was originally assigned anywhere from zero to ten recommendations, which were ranked in order of importance. Complete tributary recommendations for each subbasin can be found in each of the five subbasin sections of this report.

The top three improvement recommendations in each tributary were summed for each subbasin (Table 2). In terms of the most frequently given recommendations in each subbasin, the Northern Subbasin had Bank, Canopy, and Pool recommendations for seven out of ten tributaries surveyed, the Eastern Subbasin had a Bank recommendation for 12 out of 18 tributaries surveyed, the Southern Subbasin had a Cover recommendation for 12 out of 14 tributaries surveyed, and the Western Subbasin had a Cover recommendations for 13 out of 17 tributaries surveyed.

Table 2. Occurrence of improvement recommendations in first three ranks in surveyed streams.

Subbasin	# of Surveyed Tributaries	# of Surveyed Stream Miles	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Live-stock	Fish Passage
Northern	10	20.9	7	4	7	2	7	3	0	0	0	0
Eastern	18	34.9	12	7	9	6	9	8	1	2	0	0
Southern	14	25.7	10	5	0	0	11	12	1	5	0	1
Western	18	49.9	11	2	6	3	11	13	0	2	0	3
Mattole Basin	60	131.4	40	18	22	11	38	36	2	9	0	4

Mattole Basin Profile Summary of Refugia Areas

The interdisciplinary assessment team identified and characterized refugia habitat in the Mattole Basin by using expert professional judgment and criteria developed for north coast watersheds. The criteria included measures of watershed and stream ecosystem processes, the presence and status of fishery resources, forestry and other land uses, land ownership, potential risk from sediment delivery, water quality, and other factors that may affect refugia productivity. The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales.

The most complete data available in the Mattole Basin were for sixty tributaries surveyed by CDFG. However, several basin tributaries, mostly small, were lacking data for some factors considered by the assessment team. Salmonid tributary habitat conditions in the Mattole Basin are generally best in the Southern and Western subbasins, mixed in the Eastern subbasin, and worst in the Estuary and Northern subbasins (Table 3). The following refugia area rating table summarizes subbasin salmonid refugia conditions:

Table 3. Subbasin salmonid refugia area ratings in the Mattole Basin.

Subbasin	Refugia Categories:				Other Categories:		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area/Function	Data Limited
Estuary Subbasin			X			X	X
Northern Subbasin			X				X
Eastern Subbasin			X				X
Southern Subbasin		X					X
Western Subbasin			X				X

*Ratings in this table are done on a sliding scale from best to worst. Subbasin refugia ratings are aggregated from their tributary ratings. See page 61 for a discussion of refugia criteria.

Mattole River Tributaries by Refugia Category:

High Quality Habitat, High Quality Refugia Tributaries:

Western Subbasin
Bear Creek (RM 42.8)

High Potential Refugia Tributaries:

Eastern Subbasin
Gilham Creek
Harrow Creek
Eubank Creek
McKee Creek
Painter Creek

Southern Subbasin
Bridge Creek
West Fork Bridge Creek
South Branch West Fork Bridge Creek
Vanauken Creek
Mill Creek (RM 56.2)
Upper Mattole River (> RM 56.2)
Baker Creek
Thompson Creek
Yew Creek
Lost Man Creek
Lost Man Creek Tributary

Western Subbasin
Mill Creek (RM 2.8)
North Fork Bear Creek
North Fork Bear Creek Tributary
South Fork Bear Creek
Big Finley Creek
South Fork Big Finley Creek

Medium Potential Refugia Tributaries:

Northern Subbasin
North Fork Mattole River
Sulphur Creek
Sulphur Creek Tributary #1
Sulphur Creek Tributary #2
Conklin Creek
McGinnis Creek
Oil Creek
Devils Creek
Rattlesnake Creek

Eastern Subbasin
Westlund Creek
Gilham Creek Tributary
Sholes Creek
Grindstone Creek
Little Grindstone Creek
Blue Slide Creek
Fire Creek
Box Canyon Creek
McKee Creek Tributary

Southern Subbasin
Anderson Creek
Stanley Creek
Helen Barnum Creek

Western Subbasin
Mill Creek (RM 2.8) Tributary #1
Mill Creek (RM 2.8) Tributary #2
Squaw Creek
Woods Creek
Honeydew Creek
Bear Trap Creek
East Fork Honeydew Creek
Upper East Fork Honeydew Creek
West Fork Honeydew Creek
Jewett Creek
Nooning Creek

Low Quality Habitat, Low Potential Refugia Tributaries:

Northern Subbasin
Green Ridge Creek

Eastern Subbasin
Dry Creek
Middle Creek
Fourmile Creek
North Fork Fourmile Creek

Other Related Refugia Component Categories:

Potential Future Refugia (Non-anadromous)

None Identified

Critical Contributing Tributaries:

Northern Subbasin
North Fork Mattole River

Data Limited:

Individual streams were all missing data that would have provided a more complete data set for use in the refugia analysis. In all streams rated, this involved only one or two of the factors used in the rating process and did not prevent refugia determination from being estimated.

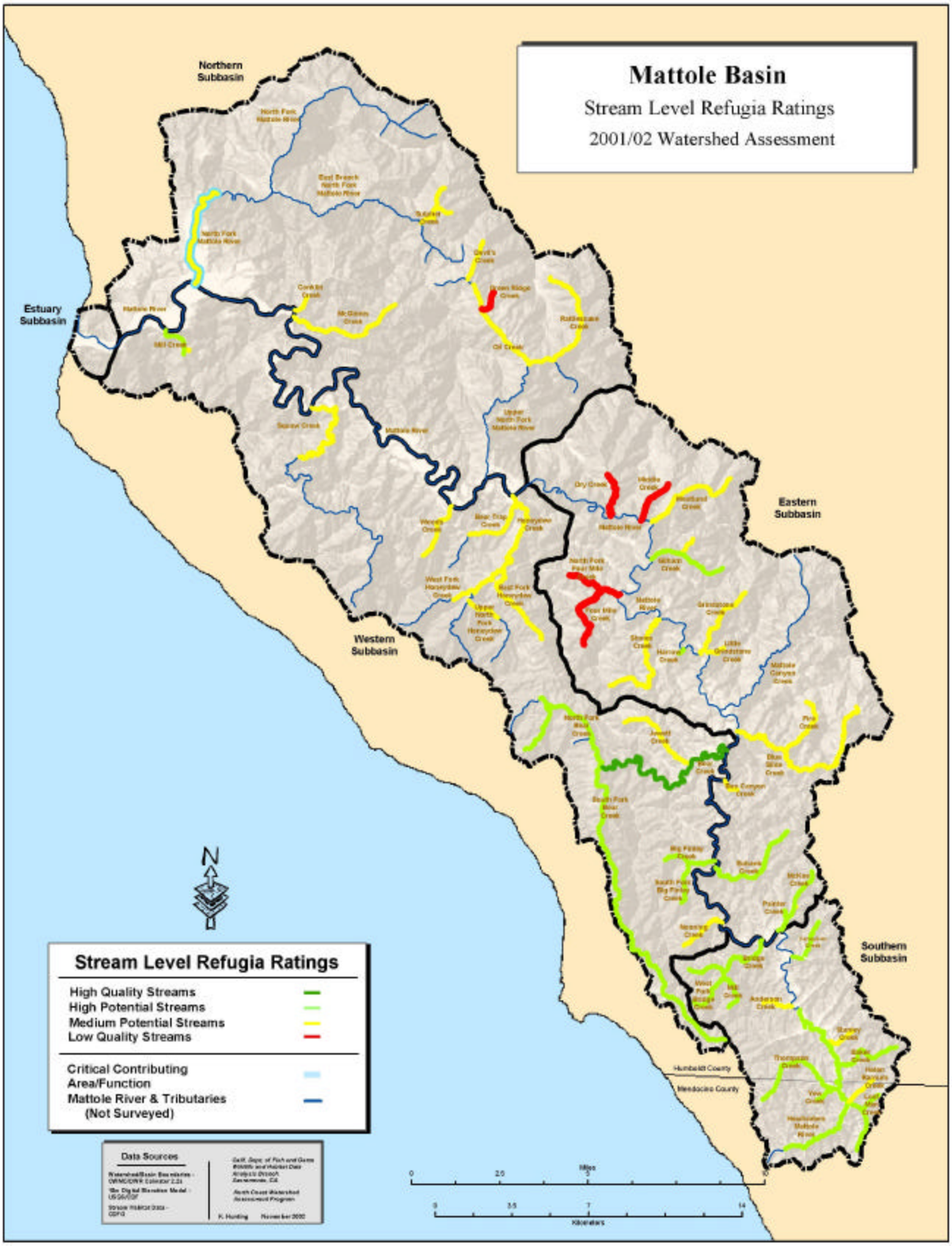

Figure 2. Refugia categories for Mattole Basin surveyed tributaries.

Mattole Basin Profile: Responses to Assessment Question Six:

What watershed and habitat improvement activities would most likely lead toward more desirable conditions in a timely, cost effective manner?

Flow and Water Quality Improvement Activities:

- Discourage unnecessary and wasteful use of water during summer low flow periods to improve stream surface flows and fish habitat, especially in the Southern Subbasin;
- Increase the use of off-stream water storage and catchments systems that collect rainwater in the winter for use in the drier summer season;
- Support local efforts to educate landowners about water storage and catchments systems, and find ways to support and subsidize development of these systems;
- Support and expand ongoing local efforts that monitor summer water and air temperatures on a continuous 24-hour basis to detect long-range trends and short-term effects on the aquatic/riparian community;
- Support efforts to determine the role of sediment in the mainstem Mattole River in elevated estuarine water temperatures.

Erosion and Sediment Delivery Reduction Activities:

- Reduce sediment deposition to the estuary by supporting a basin-wide road and erosion assessment/control program such as the Mattole Restoration Council's *Good Roads, Clear Creeks* effort. Continue to conduct and implement road and erosion assessments such as the ongoing efforts in the Dry and Westlund planning watersheds in the Eastern Subbasin. Expand road assessment efforts because of the potential for further sediment delivery from active and abandoned roads, many of which are in close proximity to stream channels, especially in the Bridge and Thompson planning watersheds in the Southern Subbasin;
- Establish monitoring stations and train local personnel to track in-channel sediment and aggraded reaches throughout the basin and especially in the North Fork Mattole and the Upper North Fork Mattole rivers, Mattole Canyon, Blue Slide, Squaw, Honeydew, and Bear creeks;
- Consider the nature and extent of naturally occurring unstable geologic terrain, landslides and landslide potential (especially Categories 4 and 5) when planning potential projects in the subbasin;
- At stream bank erosion sites, encourage cooperative efforts to reduce sediment yield to streams. CGS mapping indicates eroding banks are not a significant basin wide issue, but may be of localized importance. They occur in isolated, relatively short reaches distributed throughout the Mattole Basin;
- Based on the high incidence of unstable slopes in the Northern Subbasin, any future sub-division development proposals should be based on an existing county-imposed forty acre minimum parcel sub-division ordinances;
- Encourage the use of appropriate Best Management Practices for all land use and development activities to minimize erosion and sediment delivery to streams. For example, low impact yarding systems should be used in timber harvest operations on steep and unstable slopes to reduce soil compaction, surface disturbance, and resultant sediment yield.

Riparian and Habitat Improvement Activities:

- Where current canopy is inadequate and site conditions, including geology, are appropriate, initiate tree planting and other vegetation management to hasten the development of denser and more extensive riparian canopy, especially in the Northern Subbasin;
- Landowners and managers in the Northern and Western subbasins should work to add more large organic debris and shelter structures to streams in order to improve channel structure, channel function, habitat complexity, and habitat diversity for salmonids;
- Ensure that stream reaches with high quality habitat in the Mattole Basin are protected from degradation. This is especially important in the Southern Subbasin. The best stream conditions as evaluated by the stream reach EMDS were found in the South Fork of Vanauken Creek, Mill Creek at Mattole river-mile 56.2 (RM 56.2), Stanley Creek, Thompson Creek, Yew Creek, and Lost Man

Creek Tributary in the Southern Subbasin, and in Harrow Creek in the Eastern Subbasin. Refugia investigation criteria, which include biological parameters, indicated Bear Creek was the best stream evaluated in the Mattole Basin.

Supplemental Fish Rescue and Rearing Activities:

- Since 1982 a successful cooperative salmonid rearing facility in the Mattole Basin headwaters has been operated by the Mattole Salmon Group (MSG) and CDFG. They also operate a Chinook juvenile out-migrant rescue rearing program near the estuary, which released 2,400 coded-wire-tagged Chinook sub-yearlings in October 2002. These programs should be continued as needed to supplement wild populations while the improvements from long-term watershed and stream restoration efforts develop;
- Initiate a systematic program to monitor the effectiveness of fish rescue and rearing activities, and determine the need for the continuance of cooperative, supplemental fish rearing efforts;
- Update as scheduled the MSG/CDFG five-year plan that provides guidance to the cooperative rearing and rescue projects. Base the periodic plan updates on the findings of the effectiveness monitoring program and best available science.

Education, Research, and Monitoring Activities:

- Utilize Humboldt State University studies conducted in the early 1990s as baseline information to periodically monitor trends in estuarine conditions and fish production;
- Encourage ongoing stream inventories and fishery surveys of tributaries throughout the Mattole Basin, especially in the Northern Subbasin;
- In order to protect privacy while developing data, the possibility of training local landowners to survey their own streams and to conduct salmonid population status surveys throughout the basin would be advisable;
- Further study to investigate the affects to water quality from timberland herbicide use is recommended;
- Follow the procedures and guidelines outlined by NCRWQCB to protect water quality from ground applications of pesticides;
- Encourage appropriate fuel and chemical transportation and storage practices as well as early spill reporting and clean-up procedures;
- Conduct training as needed and desired to assist landowners, managers, consultants, and other interested parties in the construction and appropriate application of landslide occurrence and potential maps from GIS analysis

Mattole Estuary

Mattole Estuary, looking north from Prosper Ridge, King Range National Conservation Area.

Introduction

Estuaries are critical habitats for all anadromous salmonids. Estuaries provide the connection between freshwater and marine environments through which salmonids pass as juveniles during seaward migrations and as adults during spawning migrations. Estuaries are also recognized as valuable salmonid nursery areas because their ocean connection helps provide abundant food supplies, diverse habitat, and relative security from predators. Fish that utilize estuaries for an important part of their life cycle, such as salmonids, are referred to as estuarine-dependent.

During seaward migrations, all juvenile Chinook salmon, coho salmon, and steelhead utilize at least a brief estuarine residence while they undergo physiological adaptations to salt water and imprint on their natal stream. Juvenile salmonids may also extend their estuarine residency to utilize the sheltered, food rich environment for several months or a year before entering the ocean. Studies have revealed that juvenile salmonids utilizing estuaries for three months or more return to their natal stream at a higher rate than non-estuarine reared members of their cohort (Reimers 1973 , Nicholas and Hankin). Estuarine reared salmonids may be at an advantage because they enter the ocean at a larger size or during more favorable conditions. Entering the ocean at a larger size may be advantageous by allowing juvenile salmonids to avoid predation or increasing the amount of prey items that can be used for food.

Estuarine rearing is a strategy that adds diversity to juvenile salmonid life history patterns and increases the odds for survival of a species encountering a wide range of environmental conditions in both the freshwater and marine environments. Additionally, an extended estuarine residency may be especially beneficial for salmonids from rivers where low summer flows or warm water temperatures severely limit summer rearing habitat. The water quality benefits are largely dependent upon the estuary retaining its connection with cool, nutrient laden seawater.

The Mattole estuary is a seasonal bar built estuary. It acts as either an estuary or a lagoon during the course of the year. In the early summer of most years, a sand bar encroaches all the way across the mouth of the Mattole River to form a bay barrier and create a lagoon behind it. The formation of the bar is caused by a combination of sediment deposition from coastal longshore ocean currents, and decreased river flows. Lagoon formation typically occurs in late May or early June, although the mouth may remain open until

mid or late June when adequate flows are present, as was the case in 1986. On the other hand, in extremely dry years, closure will take place earlier. The lagoon opens up again in the fall, usually in October, due to increased erosion of the sand bar from increased river flow and wave action (Busby et al. 1988).

The Mattole lagoon floods an area of approximately 7 acres with the deepest sections occurring in the main channel of the river. The size and depth of the lagoon fluctuate throughout the summer, with the lagoon shrinking towards the end of the summer due to decreased river flow, increased evaporation, and increased seepage through the sand bar. Annual variations in lagoon size occur due to scouring in some areas and sediment deposition on others. Although the extent of tidal influence in the lagoon has not been quantified, tides are thought to have a minimal effect on the water level of the lagoon. Before the lagoon closes, seawater intrusion is thought to extend only a short distance, approximately one thousand feet, above the mouth of the river. Shortly after lagoon closure, incoming river water and wind-driven mixing cause the lagoon to become essentially freshwater. Intense and persistent winds cause vigorous mixing throughout the water column (Busby et al. 1988).

High levels of sediment transported from the upper watershed through periodic flooding has reduced the Mattole estuary volume and altered the physical and biologic function of the estuarine ecosystem and adjacent wetlands (MRC 1995). These impacts include elevated summer water temperatures, and lack of channel diversity and complexity. This present highly impacted state of the estuarine habitat is likely limiting the production of salmonids in the Mattole River. In fact, extensive studies, led by Humboldt State University from 1985-92, found that Chinook juveniles were suffering lethal impacts during summer rearing in the estuary (Young 1987, Busby et. al 1988). In response, the Mattole Salmon Group has initiated a springtime downstream migrant Chinook trapping and summer rearing program which has had limited success (CDFG Appendix F). Long-term watershed scale strategies to reduce sedimentation, provide habitat, and lower summer water temperatures are needed to improve the estuarine habitat, and these efforts will require private landowner and local stakeholders' cooperation.

The Mattole dune system is unique in that the aggressive and introduced European beachgrass, *Ammophila arenaria*, has not yet encroached on the Mattole dunes as it has on most coastal dunes north of San Francisco. The estuary is probably the most researched of all the Mattole subbasins in the watershed.

The Estuary Subbasin contains small sections of the Petrolia and Shenanigan Ridge CalWater 2.2a Planning Watersheds. There are no perennial tributaries in this subbasin (Figure 3).

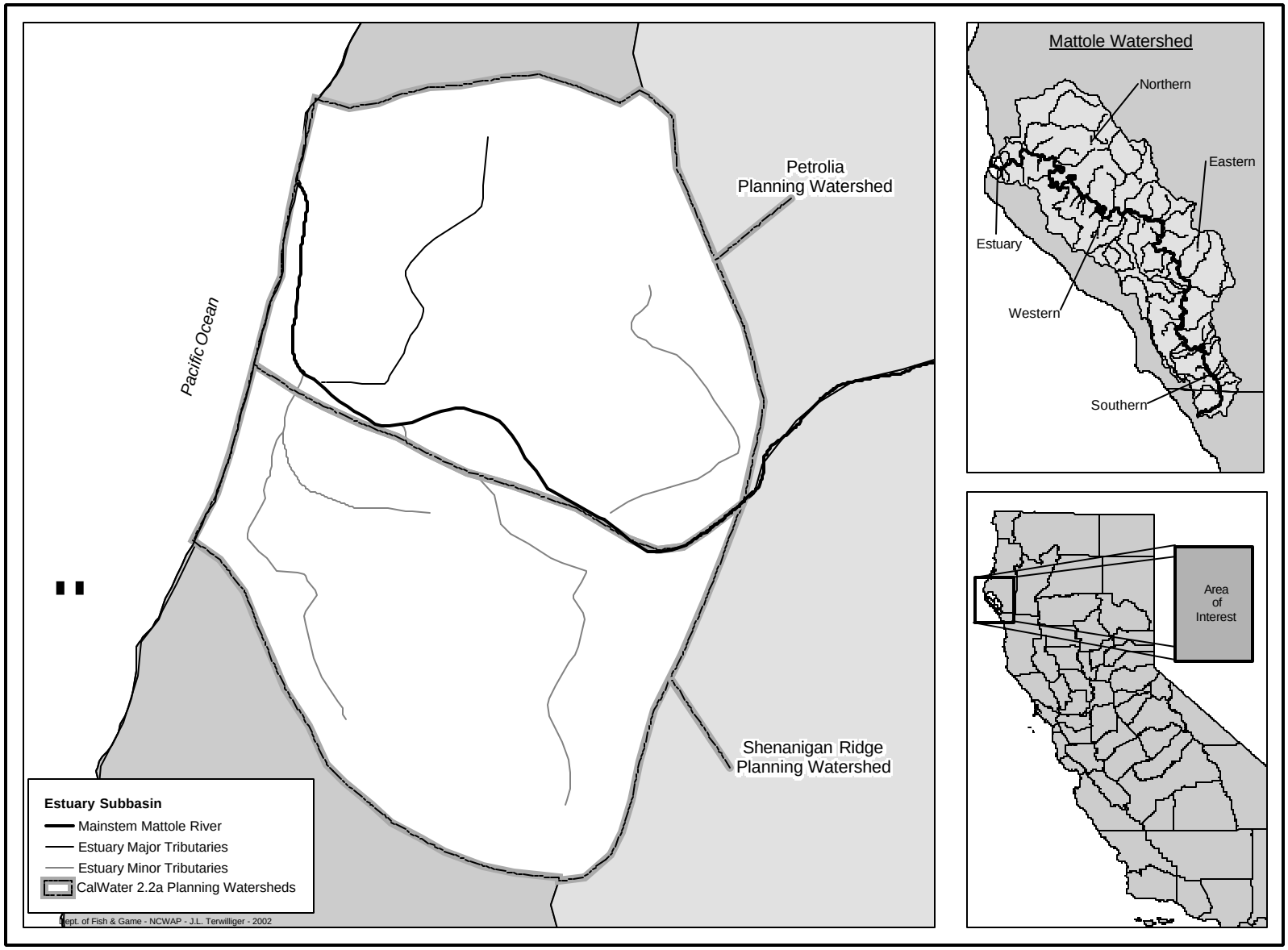

Figure 3. Mattole River Estuary Subbasin.

Stream Reach Condition EMDS

The stream reach EMDS was not used to evaluate the estuary.

Analysis of Tributary Recommendations

The small tributaries that flow into the Estuary Subbasin were not inventoried by CDFG survey crews. Therefore, no tributary recommendations exist for this subbasin. However, several recommendations for management and restoration of the estuary were given in the Mattole Restoration Council's 1995 Report, *Dynamics of Recovery*. These recommendations are not necessarily endorsed by the assessment team or any of its member agencies but are summarized in the CDFG Appendix F.

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the Estuary Subbasin by using expert professional judgment and criteria developed for north coast watersheds. The criteria included measures of watershed and stream ecosystem processes, the presence and status of fishery resources, forestry and other land uses, land ownership, potential risk from sediment delivery, water quality, and other factors that may affect refugia productivity. The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales.

The Estuary Subbasin serves as a point through which all of the Mattole Basin salmonids must pass when they go out to sea and when the return to spawn. This fact makes classifying the estuary into a refugia category difficult. Additionally, the Estuary Subbasin did not contain any tributaries surveyed by CDFG. However, the team was able to use the numerous studies of conditions in the estuary (Young 1987, Busby et al. 1988, Zedonis 1992, MRC 1995, Day 1996, MSG 2000) to make refugia designation for the Estuary Subbasin.

Salmonid habitat conditions in the Estuary Subbasin are somewhat impaired due to warm summer water temperatures and are rated as medium potential refugia. The overall medium potential refugium rating is based on year round salmonid use and the diversity of the salmonid species assemblage. In addition, the estuary serves as a critical contributing area for Mattole Basin salmonids.

Mattole Estuary Profile: Responses to Assessment Question Six:

What watershed and habitat improvement activities would most likely lead toward more desirable conditions in a timely, cost effective manner?

- Continue to support the Mattole Salmon Group's Chinook juvenile rescue rearing and fish-tagging efforts, and incorporate a program to monitor effectiveness;
- Reduce sediment deposition to the estuary by supporting a basin-wide road and erosion assessment/control program such as the Mattole Restoration Council's Good Roads, Clear Creeks effort;
- Avoid potential sedimentation directly into the estuary from the estuary's upland slopes, which are predominantly mélange bedrock and dormant landslides. Encourage the use of appropriate Best Management Practices to achieve this objective;
- Consider the nature and extent of naturally occurring unstable geologic terrain, landslides and landslide potential (especially Categories 4 and 5) when planning potential projects in the subbasin;
- Maintain and enhance existing riparian cover. Use cost share programs and conservation easements as appropriate;

- Support ongoing local efforts that monitor summer water and air temperatures on a continuous 24-hour basis to detect long-range trends and short-term effects on the aquatic/riparian community;
- Support efforts to determine the role of the mainstem Mattole River in elevated estuarine water temperatures;
- Utilize Humboldt State University studies conducted in the early 1990s as baseline information to periodically monitor trends in estuarine conditions and fish production;
- Protect instream flows in Mill Creek (RM 2.8) and Stansberry Creek for thermal refugia;
- It would be informative to further study the degree to which the cool, summer base flow from Mill Creek (RM 2.8) could temper the warmer mainstem Mattole River waters and provide an area of cool water refugia. To do so, a summer low flow connection between Mill Creek and the river would have to be established through the Mattole's gravel floodplain.

Subbasin Conclusions

Salmon and steelhead habitat conditions in Estuary Subbasin are inhospitable during summer periods resulting from naturally occurring geologic processes and basin-wide land use. High sediment deposition levels, high summer water temperatures, shallow channels, and simplified salmonid habitat indicate that present estuary stream conditions are likely not fully supportive of salmonids during summer rearing periods.

However, historical accounts indicate that estuarine conditions were favorable for salmonid populations in the past. Accordingly, there are opportunities for improvements in conditions and a great need for improvements to support juvenile rearing needs. Water temperature monitoring, riparian canopy restoration and adding LWD to improve channel complexity are examples of appropriate short term improvement activities that can be initiated directly in the estuary.

However, aquatic and channel conditions at the most downstream section of a river system are a response to watershed products transported from throughout the basin. Fine sediment and warm water are two watershed products most deleterious to the Mattole Estuary's fisheries. As such, long term improvements in the estuary must be produced by careful watershed stewardship throughout the Mattole Basin.

In general, the Mattole Basin is largely composed of a preponderance of naturally unstable and erosive terrain. In this fragile environment, land use project planning must include consideration of appropriate Best Management Practices (BMP's). These should be prescribed and followed during the course of any project to minimize erosion and sediment delivery and to prevent vegetation removal near streams. Many current landowners and managers are interested and motivated to eliminate watershed and stream impacts related to land use, and wish to accelerate a return to stable, beneficial conditions for salmonids. They are encouraged to do so, enlisting the aid and support of agency technology, experience, and funding opportunities.

Northern Mattole Subbasin

North Fork Mattole River agricultural land near Petrolia.

Introduction

The Northern Subbasin is located between the Estuary Subbasin and Honeydew Creek at River Mile 26.5 (RM 26.5) along the northeastern side of the Mattole mainstem. Eighteen perennial streams drain a watershed area of 98 square miles. Figure 4 shows Northern Subbasin tributaries and CalWater 2.2a Planning Watersheds. Elevations range from five feet at the estuary to approximately 2,500 feet in the headwaters of the tributaries.

The Northern Subbasin is largely managed for timber production and cattle ranching. The town of Petrolia is located in this subbasin at the confluence of the North Fork Mattole River and the Mattole River. Several back-to-land homesteads are located near Petrolia. Controversies concerning old-growth timber harvest issues are focused on Rainbow and Long ridges in this subbasin. The Northern Subbasin is made up of nine complete CalWater Units and most of the Petrolia CalWater Unit. There are 69.6 perennial stream miles in 18 perennial tributaries in this subbasin (Table 4). Ten of these tributaries have been inventoried by CDFG. There were 17 reaches, totaling 20.9 miles in the inventory surveys. The inventories included channel and habitat typing, and biological sampling.

Table 4. Northern Subbasin with estimated anadromy.

Stream	CDFG Survey (Y/N)	Survey Length (miles)	Estimated Anadromous Habitat Length (miles)*	Reach	Channel Type
Jim Goff Gulch	N		0.7		
Jeffry Gulch	N				
North Fork Mattole River	Y		8.0		
	Y	2.6		1	C3
	Y	0.4		2	B3
East Branch North Fork Mattole River	N		0.9		
Sulphur Creek	Y	0.5		1	B4
Sulphur Creek Tributary #1	Y	0.1		1	C4
Sulphur Creek Tributary #2	Y	0.5		1	B4
Mill Creek (RM 5.5)	N		1.3		
Conklin Creek	Y	0.6	2.2	1	C4
McGinnis Creek	Y		3.1		
	Y	3.0		1	C4
	Y	0.7		2	B3
Thornton Creek	N				
Pritchett Creek	N				
Singley Creek	N				
Holman Creek	N				
Upper North Fork Mattole River	N		3.5		
Oil Creek	Y		3.3		
	Y	0.3		1	A1
	Y	2.5		2	B2
	Y	0.3		3	A2
Green Ridge Creek	Y	0.7	0.6	1	A2
Devils Creek	Y		0.8		
	Y	0.7		1	B2
	Y	0.7		2	A3
Rattlesnake Creek	Y		3.0		
	Y	0.5		1	B2
	Y	1.4		2	B1
	Y	2.4		3	A3

* Data from the Mattole Salmon Group.

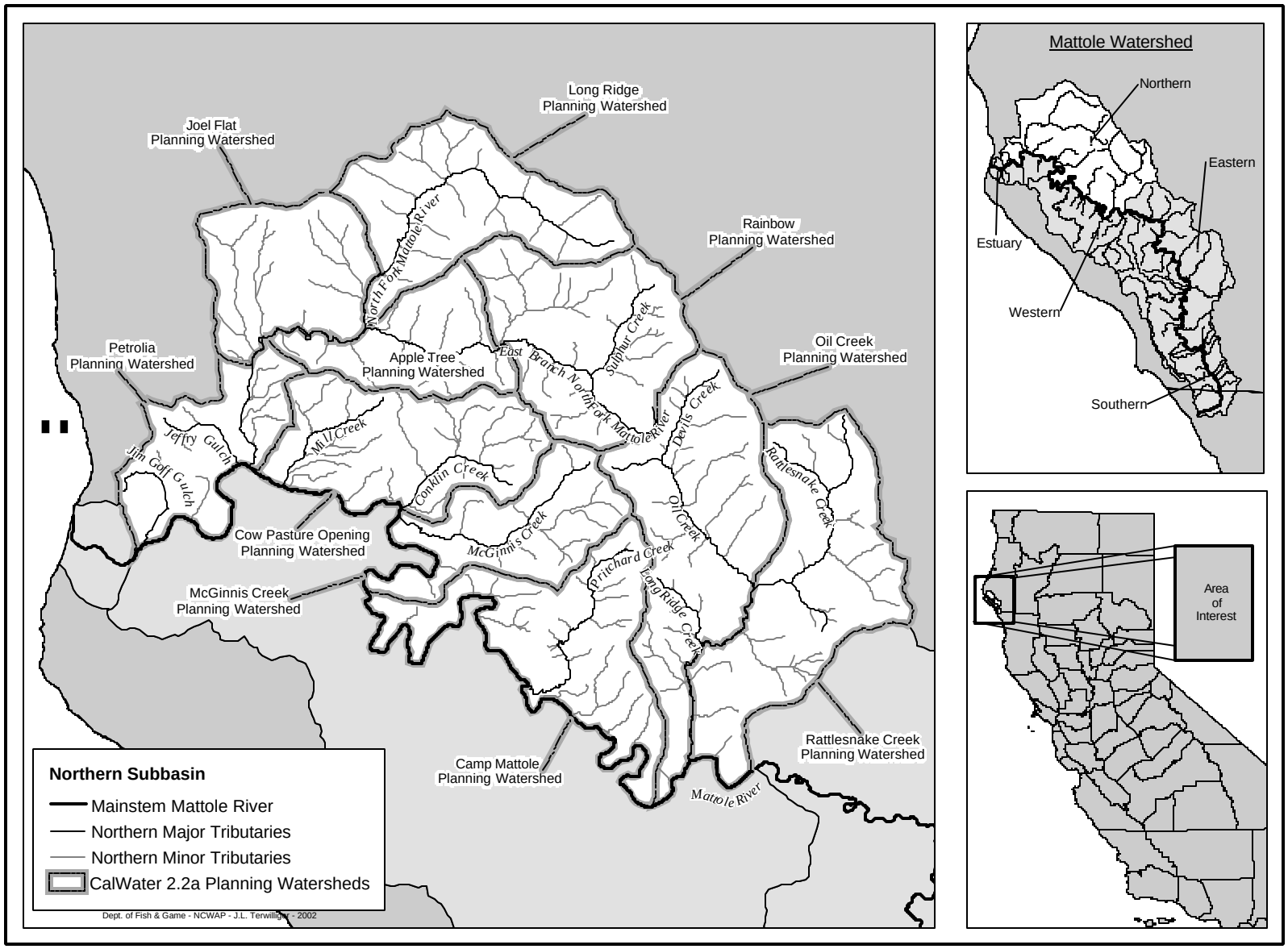

Figure 4. Mattole Northern Subbasin.

Stream Reach Condition EMDS

The anadromous reach condition EMDS evaluates the conditions for salmonids in a stream reach based upon water temperature, riparian vegetation, stream flow, and in channel characteristics. Data used in the Reach EMDS come from CDFG stream inventories. Currently, data exist in the Mattole Basin to evaluate overall reach, canopy, in channel, pool quality, pool depth, pool shelter, and embeddedness conditions for salmonids. More details of how the EMDS system calculates habitat variables can be found in the EMDS Appendix C. EMDS calculations and conclusions are pertinent only to surveyed streams and are based on conditions present at the time of individual survey.

EMDS stream reach scores were weighted by stream length to obtain overall scores for tributaries and the entire Northern Subbasin. Weighted average reach conditions on surveyed streams in the Northern Subbasin were evaluated by the EMDS as somewhat unsuitable for salmonids (Table 5). Suitable conditions exist for canopy in Sulphur Creek and Sulphur Creek Tributary #1; and for embeddedness in Sulphur Creek. Unsuitable conditions exist for reach, in channel, and pool shelter in all tributaries evaluated.

Table 5. EMDS anadromous reach condition model results for the Northern Subbasin.

Stream	Reach	Water Temperature	Canopy	Stream Flow	In Channel	Pool Quality	Pool Depth	Pool Shelter	Embeddedness
Northern Subbasin	-	**U**	- -	**U**	-	- -	- -	- -	- -
Sulphur Creek	-	U	+	U	-	- -	- - -	- -	+
Sulphur Creek Tributary #1	-	U	+++	U	-	- - -	- - -	- - -	U
Sulphur Creek Tributary #2	-	U	-	U	-	- -	- - -	-	-
Conklin Creek	-	U	- - -	U	-	- - -	- - -	- - -	U
Oil Creek	-	U	- - -	U	-	- -	- -	- - -	- - -
Green Ridge Creek	-	U	- - -	U	-	- - -	- - -	- - -	- -
Devils Creek	-	U	- - -	U	-	U	U	- - -	- - -
Rattlesnake Creek	-	U	- - -	U	-	- - -	- - -	- - -	- - -

Key: +++ Fully Suitable; ++ Moderately Suitable; + Somewhat Suitable; U Undetermined; - - - Fully Unsuitable; - - Moderately Unsuitable; - Somewhat Unsuitable

Analysis of Tributary Recommendations

CDFG inventoried 20.9 miles on ten tributaries in the Northern Subbasin. A CDFG biologist selected and ranked recommendations for each of the inventoried streams, based upon the results of these standard CDFG habitat inventories (Table 6). More details about the tributary recommendation process are given in the Mattole Synthesis Section of the Watershed Profile.

Table 6. Ranked tributary recommendations summary in the Northern Subbasin based on CDFG stream inventories.

Stream	Number of Surveyed Stream Miles	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Livestock	Fish Passage
North Fork Mattole River	3.0	1	2	3	4	6	5				
Sulphur Creek	1.4	1	2	5		3	4				
Sulphur Creek Tributary #1	0.1	2	3	6		1	5	4			
Sulphur Creek Tributary #2	0.5	3	4	5		1	2				

Stream	Number of Surveyed Stream Miles	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Livestock	Fish Passage
Conklin Creek	0.6	3	4	2	1	5	6				
McGinnis Creek	5.9	1	2	3	4	5	6				
Oil Creek	3.1	2		1	4	3	5		6		
Green Ridge Creek	0.7	4		2		1	3				
Devils Creek	1.4	4		2		1	3				
Rattlesnake Creek	4.2	5		1	2	3	4				

Bank = stream banks are failing and yielding fine sediment into the stream; Roads = fine sediment is entering the stream from the road system; Canopy = shade canopy is below target values; Temp = summer water temperatures seem to be above optimum for salmon and steelhead; Pool = pools are below target values in quantity and/or quality; Cover = escape cover is below target values; Spawning Gravel = spawning gravel is deficient in quality and/or quantity; LDA = large debris accumulations are retaining large amounts of gravel and could need modification; Livestock = there is evidence that stock is impacting the stream or riparian area and exclusion should be considered; Fish Passage = there are barriers to fish migration in the stream.

In order to further examine Northern Subbasin issues through the tributary recommendations given in CDFG stream surveys, the top three ranking recommendations for each tributary were collapsed into five different recommendation categories: Erosion/Sediment, Riparian/Water Temp, Instream Habitat, Gravel/Substrate, and Other (Table 7). When examining recommendation categories by number of tributaries, the most important recommendation category in the Northern Subbasin is Erosion/Sediment.

Table 7. Top three ranking recommendation categories by number of tributaries in the Northern Subbasin.

Northern Subbasin Target Issue	Related Table Categories	Count
Erosion / Sediment	Bank / Roads	11
Riparian / Water Temp	Canopy / Temp	9
Instream Habitat	Pool / Cover	10
Gravel / Substrate	Spawning Gravel / LDA	0
Other	Livestock / Barrier	0

However, comparing recommendation categories in the Northern Subbasin by number of tributaries could be confounded by the differences in the number of stream miles surveyed on each tributary. Therefore, the number of stream miles in each subbasin assigned to various recommendation categories was calculated (Figure 5). When examining recommendation categories by number of stream miles, the most important recommendation categories in the Northern Subbasin are Riparian/Water Temp, Instream Habitat, and Erosion/Sediment. These comprise the top tier of recommended improvement activity focus areas.

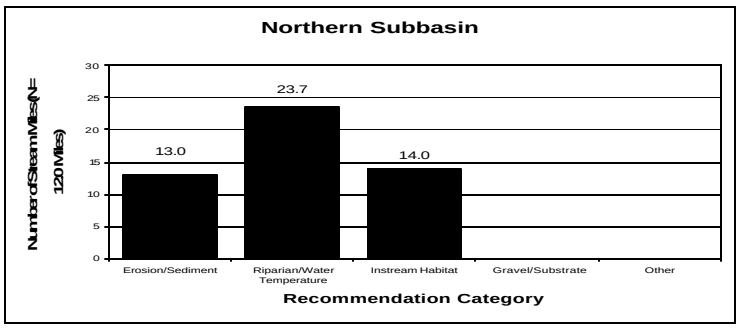

Figure 5. Recommendation categories by stream miles in the Northern Subbasin.

The high number of Riparian/Water Temperature, Instream Habitat, and Erosion/Sediment Recommendations across the Northern Subbasin indicates that high priority should be given to restoration projects emphasizing riparian replanting, pools, cover, and sediment reduction.

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the Northern Subbasin by using expert professional judgment and criteria developed for north coast watersheds. The criteria included measures of watershed and stream ecosystem processes, the presence and status of fishery resources, forestry and other land uses, land ownership, potential risk from sediment delivery, water quality, and other factors that may affect refugia productivity. The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales.

The most complete data available in the Northern Subbasin were for tributaries surveyed by CDFG. However, some tributaries were still lacking data for some factors considered.

Salmonid habitat conditions in the Northern Subbasin on surveyed streams are generally rated as medium potential refugia. Sulphur Creek Tributary #1 and Rattlesnake Creek provide the best salmonid habitat in this subbasin, while Green Ridge Creek is the only surveyed tributary to provide low quality refugia. Additionally, the North Fork Mattole River serves as a critical contributing area. The following refugia area rating table summarizes subbasin salmonid refugia conditions:

Table 8. Tributary salmonid refugia area ratings in the Northern Subbasin.

Stream	Refugia Categories*:				Other Categories:		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area/Function	Data Limited
North Fork Mattole River			X			X	X
Sulphur Creek			X				X
Sulphur Creek Tributary #1			X				X
Sulphur Creek Tributary #2			X				X
Conklin Creek			X				X
McGinnis Creek			X				X
Oil Creek			X				X
Green Ridge Creek				X			X
Devils Creek			X				X
Rattlesnake Creek			X				
Subbasin Rating			X				

**Ratings in this table are done on a sliding scale from best to worst. See page 61 for a discussion of refugia criteria.*

Northern Subbasin Profile: Responses to Assessment Question Six:

What watershed and habitat improvement activities would most likely lead toward more desirable conditions in a timely, cost effective manner?

- Encourage more stream inventories and fishery surveys of tributaries within this subbasin;
- In order to protect privacy while developing data, the possibility of training local landowners to survey their own streams and conduct salmonid population status surveys should be developed;
- Several years of monitoring summer water and air temperatures to detect trends using continuous, 24 hour monitoring thermographs should be done. Continue temperature monitoring efforts in the North Fork Mattole River, Sulphur Creek, and the Upper North Fork Mattole River, and expand

efforts into other subbasin tributaries. Study the role of seeps and springs as cold water refugia in Oil and Rattlesnake creeks;

- Where current canopy is inadequate and site conditions, including geology, are appropriate, initiate tree planting and other vegetation management to hasten the development of denser and more extensive riparian canopy. Low canopy density measurements were found in Conklin, Oil, Green Ridge, Devils, and Rattlesnake creeks;
- Maintain and enhance existing riparian cover. Use cost share programs and conservation easements as appropriate;
- Landowners and managers in this subbasin should be encouraged to add more large organic debris and shelter structures in order to improve channel structure, channel function, habitat complexity, and habitat diversity for salmonids. Pool shelter has the lowest suitability for salmonids in Sulphur Creek Tributary #1, Conklin, and Green Ridge creeks;
- Establish monitoring stations and train local personnel to track in-channel sediment and aggraded reaches throughout the subbasin and especially in the lower reaches of the North Fork Mattole River and the Upper North Fork Mattole River;
- Consider the nature and extent of naturally occurring unstable geologic terrain, landslides and landslide potential (especially Categories 4 and 5) when planning potential projects in the subbasin;
- Encourage the use of appropriate Best Management Practices for all land use and development activities to minimize erosion and sediment delivery to streams. For example, low impact yarding systems should be used in timber harvest operations on steep and unstable slopes to reduce soil compaction, surface disturbance, and resultant sediment yield;
- Based on the high incidence of unstable slopes in this subbasin, any future sub-division development proposals should be based on existing county-imposed forty acre minimum parcel sub-division ordinances;
- At stream bank erosion sites, encourage cooperative efforts to reduce sediment yield to streams. CDFG stream surveys indicated Sulphur Creek, Sulphur Creek Tributaries 1 and 2, Conklin Creek, Oil Creek, and the lower reaches of the North Fork Mattole River have bank stabilization activities as a top tier tributary improvement recommendation. Rattlesnake, McGinnis, Green Ridge, and Devils creeks also have eroding banks mapped by CGS. These could be of localized importance to reduce stream fine sediment levels;
- Continue efforts such as road erosion proofing, improvements, and decommissioning throughout the basin to reduce sediment delivery to the Mattole River and its tributaries. CDFG stream surveys indicated Sulphur Creek and Sulphur Creek Tributary #1 have road sediment inventory and control as a top tier tributary improvement recommendation.

Subbasin Conclusions

The Northern Subbasin appears to be the most impacted of the Mattole subbasins, due to naturally occurring geologic processes and land use. High channel sedimentation levels, high summer water temperatures, simplified salmonid habitat, and a lack of high quality spawning gravels indicate that present stream conditions may not be fully supportive of salmonids in many stream reaches in this subbasin. However, historical accounts indicate that stream conditions were favorable for salmonid populations in the past. Accordingly, there are abundant opportunities for improvements in watershed stream conditions and a great need to restore areas of stream refugia. Surveys by landowners, water temperature monitoring, riparian canopy restoration, improvements to channel complexity such as additional LWD are examples of such opportunities. The preponderance of naturally unstable and erosive terrain should be considered before project implementation and appropriate BMP's should be followed to minimize erosion and sediment delivery to streams. Current landowners and managers interested and motivated to eliminate impacts related to land use and accelerate a return to the stable, beneficial conditions for salmonids are encouraged to do so, enlisting the aid and support of agency technology, experience, and funding opportunities.

Eastern Mattole Subbasin

Looking southeast to Gilham Butte

Introduction

The Eastern Subbasin is located between Honeydew Creek, at river mile 26.5 (RM 26.5) and Bridge Creek (RM 52.1) along the eastern side of Wilder Ridge, at Whitethorn Junction, for a distance of about 25.6 river miles. Fifteen perennial streams drain a watershed area of 79 square miles. Elevations range from 344 feet at Honeydew Creek to approximately 2,300 feet in the headwaters of the tributaries. The Eastern Subbasin is made up of six complete CalWater Units (Figure 6). There are 54.0 perennial stream miles in 15 perennial tributaries in this subbasin (Table 9). Eighteen of these tributaries have been inventoried by CDFG. There were 26 reaches, totaling 34.9 miles in the inventory surveys. The inventories included channel and habitat typing, and biological sampling.

Table 9. Streams with estimated anadromy in the Eastern Subbasin.

Stream	CDFG Survey (Y/N)	CDFG Survey Length (miles)	Estimated Anadromous Habitat Length (miles)*	Reach	Channel Type
Dry Creek	Y	1.6	3.0	1	F4
Middle Creek	Y	1.4	2.1	1	B4
Westlund Creek	Y		3.1		
	Y	2.3		1	B4
	Y	0.9		2	A4
Gilham Creek	Y	1.9		1	B4
	Y	0.7		2	A3
Gilham Creek Tributary	Y	0.6		1	B4
Duncan Creek	N				
Four Mile Creek	Y		3.1		
	Y	0.5		1	C4
	Y	0.7		2	A4
North Fork Four Mile Creek	Y				
	Y	0.5		1	C4
	Y	0.7		2	A4
Sholes Creek	Y	4.0	2.0	1	B4
Harrow Creek	Y	0.2	0.2	1	B3
Little Grindstone Creek	Y	0.6		1	B4
Grindstone Creek	Y	2.6	0.3	1	B4
Mattole Canyon	N		6.0		
Blue Slide Creek	Y	6.3	7.0	1	F4
Fire Creek	Y	2.0		1	F4
Deer Lick Creek	N				
Box Canyon Creek	Y				
	Y	0.2		1	F4
	Y	0.2		2	B4
	Y	0.2		3	B2
Eubank Creek	Y		3.2		
	Y	3.0		1	B1
	Y	0.3		2	B4
Sinkyone Creek	N				
McKee Creek	Y		2.1		
	Y	0.7		1	B3
	Y	1.5		2	F4
McKee Creek Tributary #1	Y	0.1		1	
Painter Creek	Y	0.3	1.1	1	F4

* Data from the Mattole Salmon Group.

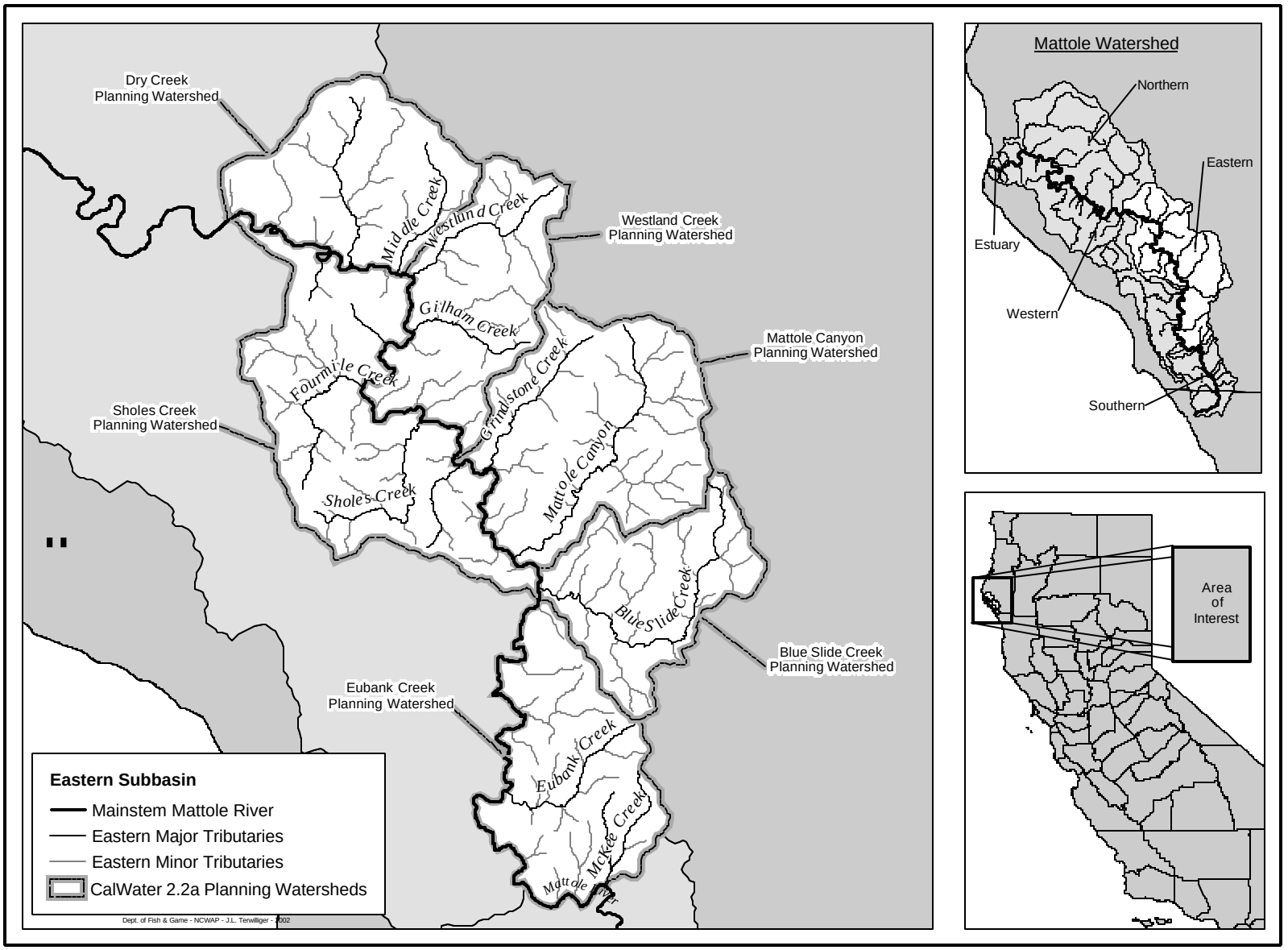

Figure 6. Mattole Eastern Subbasin.

Stream Reach Condition EMDS

The anadromous reach condition EMDS evaluates the conditions for salmonids in a stream reach based upon water temperature, riparian vegetation, stream flow, and in channel characteristics. Data used in the Reach EMDS come from CDFG Stream Inventories. Currently, data exist in the Mattole Basin to evaluate overall reach, canopy, in channel, pool quality, pool depth, pool shelter, and embeddedness conditions for salmonids. More details of how the EMDS functions are in the EMDS Appendix C. EMDS calculations and conclusions are pertinent only to surveyed streams and are based on conditions present at the time of individual survey.

EMDS stream reach scores were weighted by stream length to obtain overall scores for tributaries and the entire Eastern Subbasin. Weighted average reach conditions on surveyed streams in the Eastern Subbasin as evaluated by the EMDS are somewhat unsuitable for salmonids (Table 10). Suitable conditions exist for reach, in channel, pool quality, and pool depth in Harrow Creek; for canopy in ten tributaries; and for embeddedness in Painter Creek. Unsuitable conditions exist for pool shelter in all tributaries evaluated.

Table 10. EMDS anadromous reach condition model results for the Eastern Subbasin.

Stream	Reach	Water Temperature	Canopy	Stream Flow	In Channel	Pool Quality	Pool Depth	Pool Shelter	Embeddedness
Eastern Subbasin	-	**U**	+	**U**	-	- -	- -	- -	- -
Dry Creek	-	U	- - -	U	-	- - -	- - -	- - -	- - -
Middle Creek	-	U	- -	U	-	- - -	- - -	- - -	- - -
Westlund Creek	-	U	++	U	-	- - -	- - -	- - -	- -
Gilham Creek	-	U	+	U	-	- -	- - -	- -	- -
Gilham Creek Tributary	-	U	+	U	-	- - -	- - -	- - -	- -
Fourmile Creek	-	U	- -	U	-	- - -	- - -	- - -	- -
North Fork Fourmile Creek	-	U	- -	U	-	- - -	- - -	- - -	- - -
Sholes Creek	-	U	++	U	-	- -	- - -	- -	- - -
Harrow Creek	+	U	+++	U	+	+	+++	- -	- -
Grindstone Creek	-	U	- -	U	-	- - -	- - -	- - -	- - -
Little Grindstone Creek	-	U	+++	U	-	- - -	- - -	- - -	- -
Fire Creek	-	U	-	U	-	- -	- - -	- -	- - -
Eubanks Creek	-	U	++	U	-	-	-	-	- -
McKee Creek	-	U	++	U	-	- -	- -	- -	-
McKee Creek Tributary	-	U	++	U	-	- - -	- - -	- - -	-
Painter Creek	-	U	+	U	-	- - -	- - -	- - -	+

Key: +++ Fully Suitable; ++ Moderately Suitable; + Somewhat Suitable; U Undetermined; - - - Fully Unsuitable; - - Moderately Unsuitable; - Somewhat Unsuitable

Analysis of Tributary Recommendations

CDFG inventoried 34.9 miles on 18 tributaries in the Eastern Subbasin. In Table 11, a CDFG biologist selected and ranked recommendations for each of the inventoried streams, based upon the results of these standard CDFG habitat inventories. More details about the tributary recommendation process are given in the Mattole Synthesis Section of the Watershed Profile.

Table 11. Ranked tributary recommendations summary in the Eastern Subbasin based on CDFG stream inventories.

Stream	# of Surveyed Stream Miles	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Livestock	Fish Passage
Dry Creek	1.6	4	6	2	1	3	5				
Middle Creek	1.4	1	2	3	6	5	4				
Westlund Creek	3.2	1	2		5	3	4		6		
Gilham Creek	1.9	1	2	7		5	3	4	6		8
Gilham Creek Tributary #1	0.6	1	2	6		4	3	5			

Stream	# of Surveyed Stream Miles	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Livestock	Fish Passage
Fourmile Creek	2.9	4	5	3	2	1	6		7		
North Fork Fourmile Creek	1.2	3	4	2	1	5	6	7			
Sholes Creek	4.0	2	3	6	7	4	1		5		
Harrow Creek	0.2	3	4	7		6	5	1	2		
Little Grindstone Creek	0.6	3	4	6		1	2		5		
Grindstone Creek	2.6	3	6	2	1	4	5		7		
Blue Slide Creek	6.3	4	3	1	2	5	6				
Fire Creek	2.0	4	3	5	1	2	6		7		
Box Canyon Creek	0.5		5	1		2	3				4
Eubank Creek	3.3	3			5	4	2		1		
McKee Creek	2.2	3	4			1	2				
Tributary to McKee Creek	0.1	2		3		1					
Painter Creek	0.3			3		1	2				

Temp = summer water temperatures seem to be above optimum for salmon and steelhead; Pool = pools are below target values in quantity and/or quality; Cover = escape cover is below target values; Bank = stream banks are failing and yielding fine sediment into the stream; Roads = fine sediment is entering the stream from the road system; Canopy = shade canopy is below target values; Spawning Gravel = spawning gravel is deficient in quality and/or quantity; LDA = large debris accumulations are retaining large amounts of gravel and could need modification; Livestock = there is evidence that stock is impacting the stream or riparian area and exclusion should be considered; Fish Passage = there are barriers to fish migration in the stream.

In order to further examine Eastern Subbasin issues through the tributary recommendations given in CDFG stream surveys, the top three ranking recommendations for each tributary were collapsed into five different recommendation categories: Erosion/Sediment, Riparian/Water Temp, Instream Habitat, Gravel/Substrate, and Other (Table 12). When examining recommendation categories by number of tributaries, the most important recommendation category in the Eastern Subbasin is Erosion/Sediment.

Table 12. Top three ranking recommendation categories by number of tributaries in the Eastern Subbasin.

East Subbasin Target Issue:	Related Table Categories:	Count:
Erosion / Sediment	Bank / Roads	19
Riparian / Water Temp	Canopy / Temp	15
Instream Habitat	Pool / Cover	17
Gravel / Substrate	Spawning Gravel / LDA	3
Other	Livestock / Barrier	0

However, comparing recommendation categories in the Eastern Subbasin by number of tributaries could be confounded by the differences in the number stream miles surveyed on each tributary. Therefore, the number of stream miles in each subbasin assigned to the various recommendation categories was calculated (Figure 7). When examining recommendation categories by number of stream miles, the most important recommendation categories in the Eastern Subbasin are Erosion/Sediment, Riparian/Water Temp, and Instream Habitat.

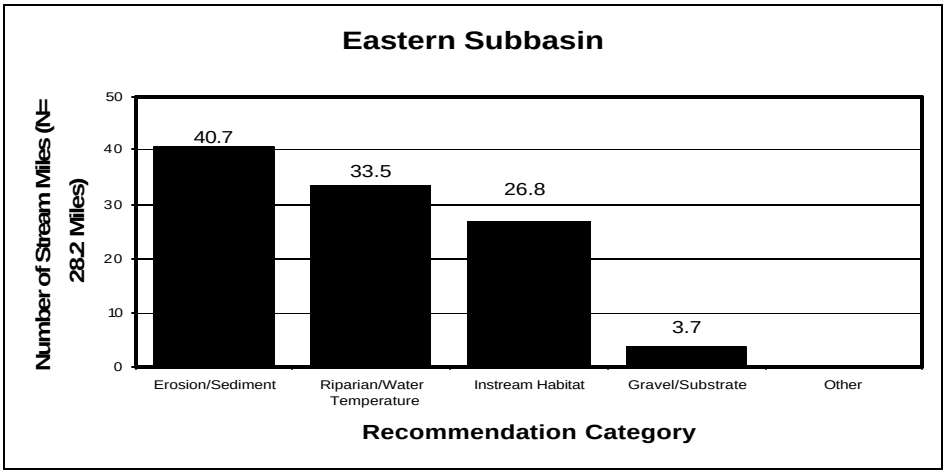

Figure 7. Recommendation categories by stream miles in the Eastern Subbasin.

The high number of Erosion/Sediment, Riparian/Water Temp, and Instream Habitat Recommendations across the Eastern Subbasin indicates that high priority should be given to restoration projects emphasizing sediment reduction, riparian replanting, pools, and cover.

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the Eastern Subbasin by using expert professional judgment and criteria developed for north coast watersheds. The criteria included measures of watershed and stream ecosystem processes, the presence and status of fishery resources, forestry and other land uses, land ownership, potential risk from sediment delivery, water quality, and other factors that may affect refugia productivity. The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales.

The most complete data available in the Eastern Subbasin were for tributaries surveyed by CDFG. However, many of these tributaries were still lacking data for some factors considered by the team.

Salmonid habitat conditions in the Eastern Subbasin on surveyed streams are generally rated as medium potential refugia. Gilham, Harrow, Eubank, McKee, and Painter creeks provide the high potential refugia in this subbasin, while Dry, Middle, and Fourmile creeks and the North Fork of Fourmile Creek provide low quality refugia. The following refugia area rating table summarizes subbasin salmonid refugia conditions:

Table 13. Tributary salmonid refugia area ratings in the Eastern Subbasin.

Stream	Refugia Categories*:				Other Categories:		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area/Function	Data Limited
Dry Creek				X			
Middle Creek				X			
Westlund Creek			X				X
Gilham Creek		X					X
Gilham Creek Tributary			X				X
Fourmile Creek				X			X
North Fork Fourmile Creek				X			X
Sholes Creek			X				X
Harrow Creek		X					X
Grindstone Creek			X				X
Little Grindstone Creek			X				X
Blue Slide Creek			X				X
Fire Creek			X				X
Box Canyon Creek			X				X
Eubank Creek		X					X
McKee Creek		X					X
McKee Creek Tributary			X				X
Painter Creek		X					X
Subbasin Rating			X				

*Ratings in this table are done on a sliding scale from best to worst. See page 61 for a discussion of refugia criteria.

Eastern Subbasin Profile: Responses to Assessment Question Six:

What watershed and habitat improvement activities would most likely lead toward more desirable conditions in a timely, cost effective manner?

- Establish monitoring stations and train local personnel to track in-channel sediment and aggraded reaches throughout the subbasin and especially in Mattole Canyon and Blue Slide creeks;
- At stream bank erosion sites, encourage cooperative efforts to reduce sediment yield to streams. CDFG stream surveys indicate Middle, Westlund, Gilham, Gilham Creek Tributary, North Fork Fourmile, Sholes, Harrow, Little Grindstone, Grindstone, Eubank, and McKee creeks, and the Tributary to McKee Creek have bank stabilization activities as a top tier tributary improvement recommendation. These could be of localized importance to reduce stream fine sediment levels;
- Continue to conduct and implement road and erosion assessments such as the ongoing efforts in the Dry and Westlund planning watersheds. Initiate road improvements and erosion proofing throughout the subbasin to reduce sediment delivery. Middle, Westlund, Gilham, Gilham Creek Tributary, Sholes, Blue Slide, and Fire creeks had road sediment inventory and control as one of their top tier tributary improvement activity recommendations;
- Several years of monitoring summer water and air temperatures to detect trends using continuous, 24 hour monitoring thermographs should be done. Continue temperature monitoring efforts in Dry, Middle, Westlund, Sholes, Mattole Canyon, Blue Slide, Eubank, Gilham, and Grindstone creeks. Start temperature monitoring in Little Grindstone, Fire, and Box Canyon creeks;
- Where current canopy is inadequate and site conditions, including geology, are appropriate, use tree planting and other vegetation management techniques to hasten the development of denser and more

extensive riparian canopy. Canopy density has the lowest suitability for salmonids in Dry and Blue Slide creeks;

- Landowners and managers in the this subbasin should work to add more large organic debris and shelter structures in order to improve channel structure, channel function, habitat complexity, and habitat diversity for salmonids. Pool shelter has the lowest suitability for salmonids in Dry, Middle, Westlund, Gilham Creek Tributary, Fourmile, North Fork Fourmile, Grindstone, Little Grindstone, Blue Slide, McKee Creek Tributary, and Painter creeks;
- Consider the nature and extent of naturally occurring unstable geologic terrain, landslides and landslide potential (especially Categories 4 and 5) when planning potential projects in the subbasin;
- Encourage the use of appropriate Best Management Practices for all land use and development to minimize erosion and sediment delivery to streams;
- Encourage appropriate chemical transportation and storage practices, early spill reporting, and clean-up procedures.
- Ensure that high quality habitat within this subbasin is protected from degradation. The highest stream reach conditions as evaluated by the stream reach EMDS and refugia analysis were found in the Gilham, Harrow, Eubank, McKee, and Painter Creeks.

Subbasin Conclusions

The Eastern Subbasin appears to be variably impacted by high sediment levels, high water temperature, reduced habitat complexity, and embedded spawning gravels in some tributaries. The variability of impacts is largely the result of the natural variability of stability and erodability of the geologic terrains in the subbasin. Present stream conditions in some tributaries are less then target values beneficial to salmonids. However, historical accounts indicate that stream conditions were favorable for salmonid in the past and certain habitat factors remain favorable in some of the tributaries. Accordingly, there are opportunities for improvements in watershed stream conditions and a need to restore areas of stream refugia. Examples of recommendations to improve habitat include road improvements and erosion proofing, mitigation of stream bank erosion, monitoring stream and air temperatures, tree planting to improve riparian canopy, and increase channel complexity. The natural variability of stability and erodability of the geologic terrains should be considered before project implementation and appropriate BMP's should be followed to minimize erosion and sediment delivery to streams. Current landowners and managers interested and motivated to eliminate impacts related to land use and accelerate a return to the stable, beneficial conditions for salmonid are encouraged to do so, enlisting the aid and support of agency technology, experience, and funding opportunities.

Southern Mattole Subbasin

Redwoods in the Southern Subbasin near Whitethorn

Introduction

The Southern Subbasin is located south of Bridge Creek (RM 52.1) and McKee Creek (RM 52.8), both near Thorn Junction, and continues upstream to the Mattole's headwaters near Four Corners (RM 1.5), a distance along the Mattole mainstem of about 9.4 river miles (Figure 8). Twenty-six perennial streams drain a watershed area of 28 square miles. Elevations range from930 feet at Bridge Creek to approximately 1,500 feet in the headwaters of the tributaries. There are 23.5 perennial stream miles in 26 perennial tributaries in this subbasin (Table 14). Fourteen of these tributaries have been inventoried by CDFG. There were 21 reaches, totaling 25.7 miles in the inventory surveys. The inventories included channel and habitat typing, and biological sampling.

Table 14. Streams with estimated anadromy in the Southern Subbasin.

Stream	CDFG Survey (Y/N)	CDFG Survey Length (miles)	Estimated Anadromous Habitat Length (miles)*	Reach	Channel Type
Bridge Creek	Y		2.8		
	Y	3.1			
	Y	0.7		1	F4
	Y	0.5		2	
	Y	1.9		3	F4
West Fork of Bridge Creek (Robinson Creek)	Y		1.5		
	Y	0.9		1	B4
	Y	0.5		2	C4
South Branch of the West Fork of Bridge Creek	Y	1.4	1.0	1	F4
Vanauken Creek	Y		1.1		
	Y	1.4		1	F4
	Y	0.1		2	G4
South Fork Vanauken Creek	Y	0.1			
Anderson Creek	Y	0.9	0.1	1	B3
Ravasoni Creek	N		0.0		
Mill Creek (RM 56.2)	Y	0.2	2.3	1	F4
Harris Creek	N		0.8		
Gibson Creek	N		1.0		
Upper Mattole River	Y	6.7	7.0	1	F3
Stanley Creek	Y	1.0	1.0	1	F4
Baker Creek	Y	2.2	1.7	1	F4
Thompson Creek	Y		3.2		
	Y	1.6		1	B1
	Y	1.7		2	F1
Yew Creek	Y	0.7	1.3	1	B4
Helen Barnum Creek	Y	0.9	0.6	1	E4
Lost Man Creek	Y	1.2	0.5	1	E4
Lost Man Creek Tributary	Y	1.2		1	E4
Big Alder Creek	N				
Pipe Creek	N				
Dream Stream	N				
Arcanum Creek	N				
Big Jackson Creek	N				
Phillips Creek	N		0.1		
McNasty Creek	N		1.0		
Ancestor Creek	N		0.3		

* Data from the Mattole Salmon Group.

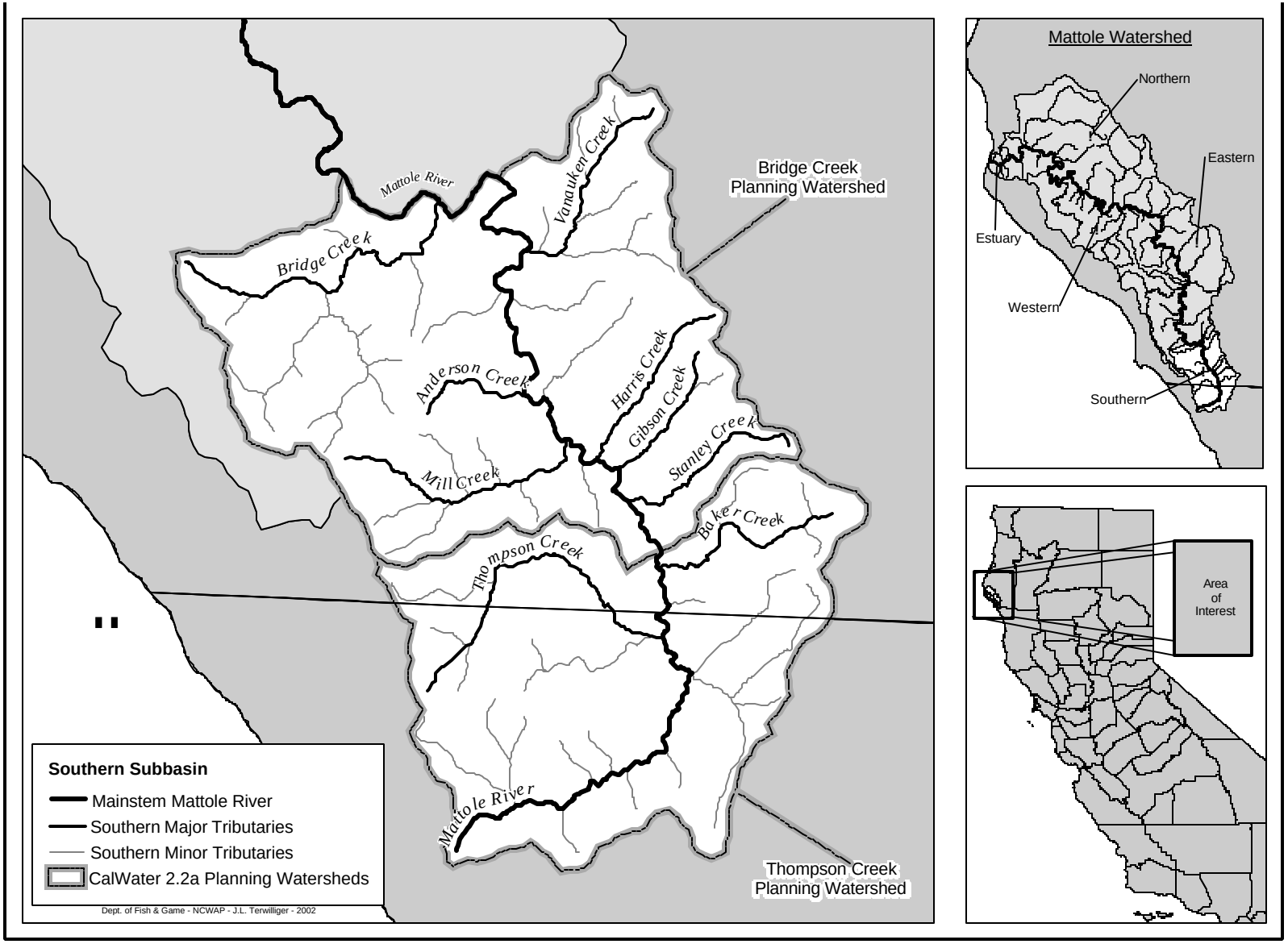

Figure 8. Mattole Southern Subbasin

Stream Reach Condition EMDS

The anadromous reach condition EMDS evaluates the conditions for salmonids in a stream reach based upon water temperature, riparian vegetation, stream flow, and in channel characteristics. Data used in the Reach EMDS come from CDFG Stream Inventories. Currently, data exist in the Mattole Basin to evaluate overall reach, canopy, in channel, pool quality, pool depth, pool shelter, and embeddedness conditions for salmonids. More details of how the EMDS functions are in the EMDS Appendix C. EMDS calculations and conclusions are pertinent only to surveyed streams and are based on conditions present at the time of individual survey.

EMDS stream reach scores were weighted by stream length to obtain overall scores for tributaries and the entire Southern Subbasin. Weighted average reach conditions on surveyed streams in the Southern Subbasin as evaluated by the EMDS are somewhat unsuitable for salmonids (Table 15). Suitable conditions exist for reach in seven tributaries; for canopy in every tributary evaluated except for Helen Barnum Creek; for in channel in four tributaries; for pool quality in eight tributaries; for pool depth in eight tributaries; for pool shelter in four tributaries, and for embeddedness in four tributaries.

Table 15. EMDS anadromous reach condition model results for the Southern Subbasin.

Stream	Reach	Water Temperature	Canopy	Stream Flow	In Channel	Pool Quality	Pool Depth	Pool Shelter	Embeddedness
Southern Subbasin	-	U	++	U	-	+	+	-	- -
Unnamed Tributary to Mattole River	-	U	+++	U	-	+	- -	+++	- - -
Bridge Creek	-	U	++	U	-	-	U	-	- -
West Fork Bridge Creek	-	U	++	U	-	- -	- -	- -	- - -
South Branch West Fork Bridge Creek	-	U	+	U	-	- -	- - -	-	- - -
Vanauken Creek	-	U	++	U	-	- -	- -	-	- -
South Fork Vanauken Creek	+	U	+++	U	+	++	+++	+	- - -
Anderson Creek	-	U	+++	U	-	- - -	- - -	- - -	- - -
Mill Creek (Thorn Junction)	+	U	+++	U	+	+	+++	-	-
Upper Mattole River	+	U	++	U	+	+++	+++	+++	- -
Stanley Creek	+	U	+++	U	U	U	+++	- - -	-
Baker Creek	-	U	+++	U	-	-	- - -	+	+
Thompson Creek	+	U	++	U	-	+	+++	- -	- -
Yew Creek	+	U	+++	U	-	+	+++	-	- - -
Helen Barnum Creek	-	U	-	U	-	- -	- - -	-	+
Lost Man Creek	-	U	++	U	-	- -	- - -	- -	+
Lost Man Creek Tributary	+	U	++	U	+	+	+++	- -	+

Key: +++ Fully Suitable; ++ Moderately Suitable; + Somewhat Suitable; U Undetermined; - - - Fully Unsuitable; - - Moderately Unsuitable; - Somewhat Unsuitable

Analysis of Tributary Recommendations

CDFG inventoried 25.7 miles on 14 tributaries and the Upper Mattole River in the Southern Subbasin. In Table 16, a CDFG biologist selected and ranked recommendations for each of the inventoried streams, based upon the results of these standard CDFG habitat inventories. More details about the tributary recommendation process are given in the Mattole Synthesis Section of the Watershed Profile.

Table 16. Ranked tributary recommendations summary in the Southern Subbasin based on CDFG stream inventories.

Stream	# of Surveyed Stream Miles	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Livestock	Fish Passage
Bridge Creek	3.1	3	4			1	2				
West Fork Bridge Creek	1.4	3	4			1	2		5		
South Branch West Fork Bridge Creek	1.4	4	5	6	7	2	3		1		
Vanauken Creek	1.4	2	4			1			3		5
South Fork Vanauken Creek	0.1	1	2				3				
Anderson Creek	0.9	3				1	2				
Mill Creek (RM 56.2)	0.2	3	4			2	1				
Upper Mattole River	6.7	1	2			3					
Stanley Creek	1.0	2	3			4	1		6		5
Baker Creek	2.2	5	4			1	2	3			
Thompson Creek	3.3	3	4				2		1		
Yew Creek	0.7	2	3				1				
Helen Barnum Creek	0.9		3			1	2				
Lost Man Creek	1.2		4			2			3		1
Lost Man Creek Tributary #1	1.2		4			2	1		3		

Temp = summer water temperatures seem to be above optimum for salmon and steelhead; Pool = pools are below target values in quantity and/or quality; Cover = escape cover is below target values; Bank = stream banks are failing and yielding fine sediment into the stream; Roads = fine sediment is entering the stream from the road system; Canopy = shade canopy is below target values; Spawning Gravel = spawning gravel is deficient in quality and/or quantity; LDA = large debris accumulations are retaining large amounts of gravel and could need modification; Livestock = there is evidence that stock is impacting the stream or riparian area and exclusion should be considered; Fish Passage = there are barriers to fish migration in the stream.

In order to further examine Southern Subbasin issues through the tributary recommendations given in CDFG stream surveys, the top three ranking recommendations for each tributary were collapsed into five different recommendation categories: Erosion/Sediment, Riparian/Water Temp, Instream Habitat, Gravel/Substrate, and Other (Table 17). When examining recommendation categories by number of tributaries, the most important recommendation category in the Southern Subbasin is Instream Habitat.

Table 17. Top three ranking recommendation categories by number of tributaries in the Southern Subbasin.

South Subbasin Target Issue:	Related Table Categories:	Count:
Erosion / Sediment	Bank / Roads	15
Riparian / Water Temp	Canopy / Temp	0
Instream Habitat	Pool / Cover	23
Gravel / Substrate	Spawning Gravel / LDA	6
Other	Livestock / Barrier	1

However, comparing recommendation categories in the Southern Subbasin by number of tributaries could be confounded by the differences in the number stream miles surveyed on each tributary. Therefore, the number of stream miles in each subbasin assigned to the various recommendation categories was calculated (Figure 9). When examining recommendation categories by number of stream miles, the most important recommendation categories in the Southern Subbasin are Instream Habitat, Erosion/Sediment, and Gravel/Substrate.

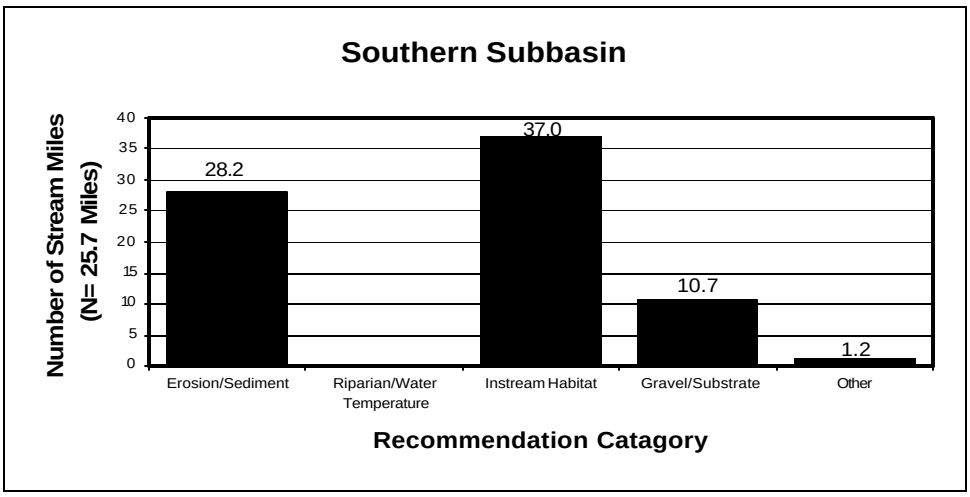

Figure 9. Recommendation categories by stream miles in the Southern Subbasin.

The high number of Instream Habitat, Erosion/Sediment, and Gravel/Substrate Recommendations across the Southern Subbasin indicates that high priority should be given to restoration projects emphasizing pools, cover, and sediment reduction.

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the Southern Subbasin by using expert professional judgment and criteria developed for north coast watersheds. The criteria included measures of watershed and stream ecosystem processes, the presence and status of fishery resources, forestry and other land uses, land ownership, potential risk from sediment delivery, water quality, and other factors that may affect refugia productivity. The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales.

The most complete data available in the Southern Subbasin were for tributaries surveyed by CDFG. However, many of these tributaries were still lacking data for some factors considered by the team.

Salmonid habitat conditions in the Southern Subbasin on surveyed streams are generally rated as high potential refugia. Most creeks provide the high potential refugia in this subbasin, while Anderson, Stanley, and Helen Barnum creeks provide medium quality refugia. In nearly all streams in this subbasin, a lack of stream flow during dry summer and fall periods lowers refugia ratings. The following refugia area rating table summarizes subbasin salmonid refugia conditions.

Table 18. Tributary salmonid refugia area ratings in the Southern Subbasin.

Stream	Refugia Categories*:				Other Categories:		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area/Function	Data Limited
Bridge Creek		X					X
West Fork Bridge Creek		X					X
South Branch West Fork Bridge Creek		X					X
Vanauken Creek		X					X
South Fork Vanauken Creek		X					X
Anderson Creek			X				X
Mill Creek (RM 56.2)		X					X
Upper Mattole River		X					X
Stanley Creek			X				X
Baker Creek		X					X
Thompson Creek		X					X
Yew Creek		X					X
Helen Barnum Creek			X				X
Lost Man Creek		X					X
Lost Man Creek Tributary		X					X
Subbasin Rating		X					

*Ratings in this table are done on a sliding scale from best to worst. See page 61 for a discussion of refugia criteria.

Southern Subbasin Profile: Responses to Assessment Question Six:

What watershed and habitat improvement activities would most likely lead toward more desirable conditions in a timely, cost effective manner?

- Encourage reducing the unnecessary and wasteful use of water to improve summer stream surface flows and fish habitat;
- Increase the use of water storage and catchment systems that collect rainwater in the winter for use in the drier summer season;
- Support local efforts to educate landowners about water storage and catchment systems, and to find ways to subsidize development of these systems;
- Ensure that this high quality habitat is protected from degradation. The highest stream reach conditions as evaluated by the stream reach EMDS and refugia analysis were found in the Bridge, West Fork Bridge, South Fork West Fork Bridge, South Fork of Vanauken, Mill (RM 56.2), Stanley, Baker, Thompson, Yew, and Lost Man creeks, the Upper Mattole River, and Lost Man Creek Tributary;
- Improve the culvert on Stanley Creek that is blocking juvenile salmonids from accessing high quality rearing habitat;
- Establish monitoring stations and train local personnel to track in-channel sediment and aggraded reaches throughout the subbasin and especially in Bridge and Thompson creeks;

- Consider the nature and extent of naturally occurring unstable geologic terrain, landslides and landslide potential (especially Categories 4 and 5) when planning potential projects in the subbasin;
- Encourage the use of appropriate Best Management Practices for all land use and development activities to minimize erosion and sediment delivery to streams. For example, low impact yarding systems should be used in timber harvest operations on steep and unstable slopes to reduce soil compaction, surface disturbance, and resultant sediment yield;
- Expand road assessment efforts because of the potential for further sediment delivery from active and abandoned roads, many of which are in close proximity to stream channels;
- Continue efforts such as road improvements, and decommissioning throughout this subbasin to reduce sediment delivery to the Mattole River and its tributaries. CDFG stream surveys indicated South Fork Vanauken Creek, the Upper Mattole River, Stanley Creek, Thompson Creek, and Yew Creek have road sediment inventory and control as a top tier tributary recommendation. In 2002, road erosion assessments and road erosion control projects were underway in the upper Mattole Basin;
- Further study of timberland herbicide use is recommended;
- Follow the procedures and guidelines outlined by NCRWQCB to protect water quality from ground applications of pesticides;
- A cooperative salmonid rearing facility exists in the headwaters, operated since 1982 by the Mattole Salmon Group. This operation has been successful and should be continued on an as needed basis in order to supplement wild populations of Chinook salmon;
- Initiate a training program for local landowners to survey their own streams and monitor salmonid populations. This will provide important data and protect privacy;
- Monitor summer water and air temperatures to detect trends using continuous 24 hour monitoring thermographs. Continue temperature monitoring efforts in Bridge, Vanauken, Baker, Yew, Thompson, Helen Barnum, Lost Man, Dream Stream, and Ancestor creeks, and expand efforts into other subbasin tributaries.

Subbasin Conclusions

Historical accounts indicate that the Southern Subbasin has supported healthy populations of Chinook salmon, coho salmon, and steelhead trout. More current surveys indicate that it continues to have the highest fish productivity in the Mattole Basin. The natural geological conditions in the subbasin are comparatively stable and stream channels within the subbasin appear to be the least impacted by features indicative of excess sediment production, transport, and storage. However, it appears that salmonid populations are currently being limited by low summer stream flows, reduced habitat complexity, high sediment levels, embedded spawning gravels, and artificial fish passage barriers. This subbasin is the most heavily populated are of the subbasin, and dewatering of streams is considered a serious problem. The subbasin has a comparatively dense network of roads located near streams and road crossings that provide potential sources of fine sediment input to streams. Residents, landowners, and land managers can help maintain and improve stream habitat through becoming educated in methods to reduce water use, remove fish passage barriers, and mitigate road related sedimentation, and may enlist the aid and support of agency technology, experience, and funding in accomplishing these goals.

Western Subbasin near Ettersburg.

Introduction

The Western Subbasin is located between Bear Creek in the estuary (RM 0.3) and the headwaters of the South Fork of Bear Creek (RM 50) along the western side of the Mattole mainstem and Wilder Ridge for a distance of about 60 miles. Elevations range from 20 feet at the estuary to approximately 2800 feet in the headwaters of the tributaries in the King Range. Kings Peak, at 4088 feet, is the highest point in the Mattole Basin. The Western Subbasin is made up of six complete CalWater Units and most of the Shenanigan Ridge CalWater Unit (Figure 10). There are 85.8 perennial stream miles in 33 perennial tributaries in this subbasin (Table 19). Eighteen of these tributaries have been inventoried by CDFG. There were 33 reaches, totaling 49.9 miles in the inventory surveys. The inventories included channel and habitat typing, and biological sampling.

Table 19. Streams with estimated anadromy in the Western Subbasin.

Stream	CDFG Survey (Y/N)	CDFG Survey Length (miles)	Estimated Anadromous Habitat Length (miles)*	Reach	Channel Type
Bear Creek	N		0.3		
Stansberry Creek	N		0.5		
Mill Creek (RM 2.8)	Y	1.1	1.4	1	B2
Mill Creek (RM 2.8) Tributary 1	Y	0.2		1	A2
Mill Creek (RM 2.8) Tributary 2	Y	0.1		1	A2
Clear Creek	N		0.7		
Indian Creek	N		1.2		
Wild Turkey Creek	N		0.1		
Green Fir Creek	N				
Squaw Creek	Y	4.1	12.7	1	F3

Stream	CDFG Survey (Y/N)	CDFG Survey Length (miles)	Estimated Anadromous Habitat Length (miles)*	Reach	Channel Type
Granny Creek	N				
Cook Gulch	N				
Saunders Creek	N		0.4		
Hadley Creek	N				
Kendall Gulch	N				
Woods Creek	Y		1.5		
	Y	1.2		1	F4
	Y	0.7		2	B4
Bundle Prairie Creek	N				
Honeydew Creek	Y		5.9		
	Y	1.4		1	F4
	Y	0.9		2	F4
	Y	1.1		3	F3
	Y	0.7		4	A2
Bear Trap Creek	Y		0.1		
	Y	2.9		1	F3
	Y	1.7		2	F2
	Y	1.6		3	B2
	Y	1.1		4	F2
High Prairie Creek	N		0.6		
East Fork Honeydew Creek	Y	2.9	6.0	1	F2
Upper East Fork Honeydew Creek	Y	1.0	0.0	1	F2
West Fork Honeydew Creek	Y	0.7	0.2	1	B2
Bear Creek	Y		6.5		
	Y	1.4		1	B2
	Y	0.3		2	A2
French Creek	N		0.4		
Jewett Creek	Y	2.7	2.4	1	F4
North Fork Bear Creek	Y		4.3		
	Y	2.5		1	B4
	Y	0.9		2	A3
North Fork Bear Creek Tributary	Y	1.4		1	B2
	Y	0.3		2	A2
South Fork Bear Creek	Y		10.7		
	Y	1.9		1	B2
	Y	4.6		2	F3
	Y	5.3		3	B3
	Y	0.3		4	F4
Little Finley Creek	N				
Big Finley Creek	Y		0.1		
	Y	1.3		1	B4
	Y	0.3		2	A2
South Fork Big Finley Creek	Y	1.3		1	B3
Nooning Creek	Y		1.5		
	Y	0.1		1	F3
	Y	1.4		2	B2

* Data from the Mattole Salmon Group.

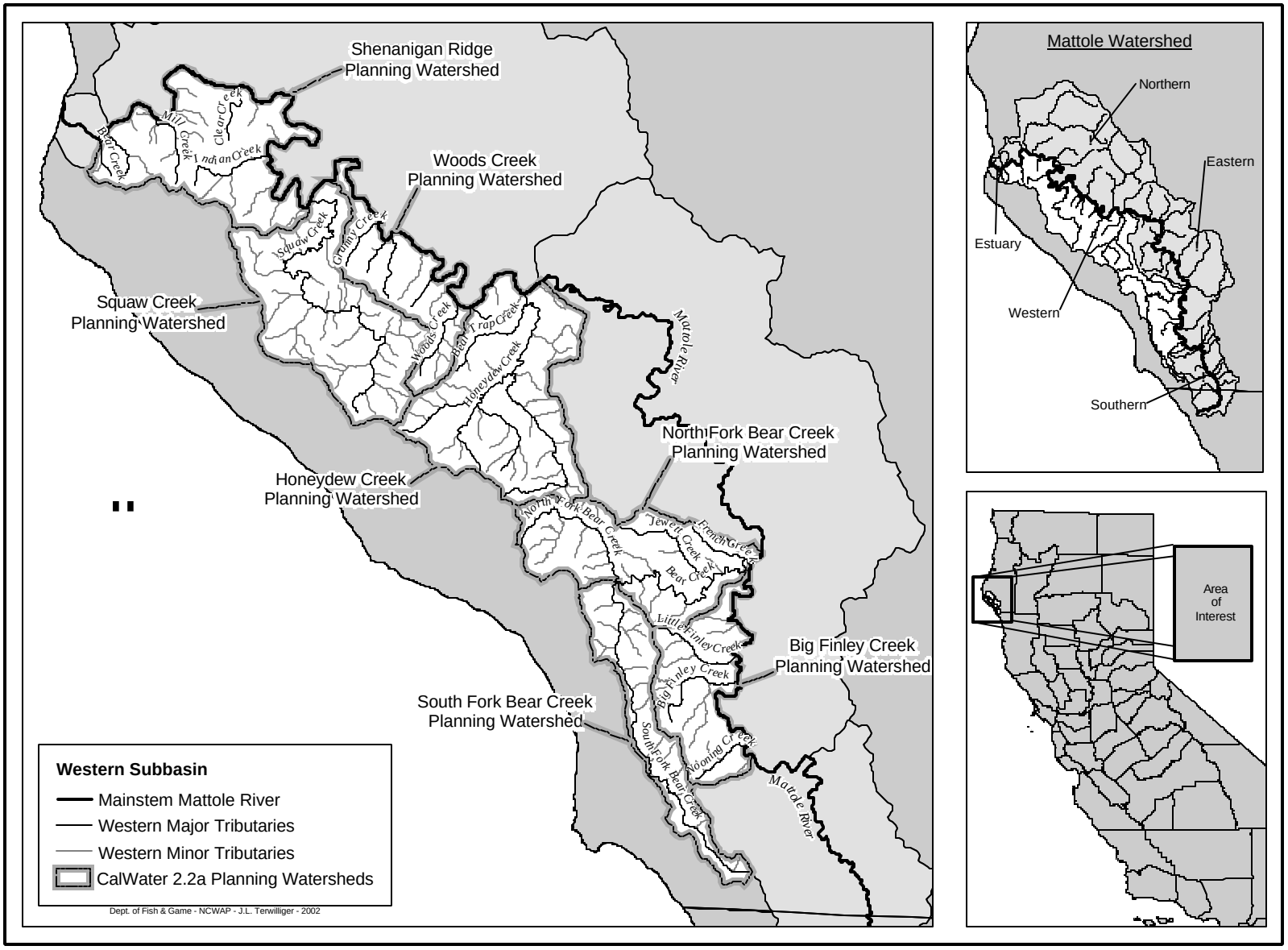

Figure 10. Mattole Western Subbasin.

Stream Reach Condition EMDS

The anadromous reach condition EMDS evaluates the conditions for salmonids in a stream reach based upon water temperature, riparian vegetation, stream flow, and in channel characteristics. Data used in the Reach EMDS come from CDFG Stream Inventories. Currently, data exist in the Mattole Basin to evaluate overall reach, canopy, in channel, pool quality, pool depth, pool shelter, and embeddedness conditions for salmonids. More details of how the EMDS functions are in the EMDS Appendix C EMDS calculations and conclusions are pertinent only to surveyed streams and are based on conditions present at the time of individual survey.

EMDS stream reach scores were weighted by stream length to obtain overall scores for tributaries and the entire Western Subbasin. Weighted average reach conditions on surveyed streams in the Western Subbasin as evaluated by the EMDS are somewhat unsuitable for salmonids (Table 20). Suitable conditions exist for reach in seven tributaries; for canopy in eight tributaries; for in channel and pool quality in Bear Creek; for pool depth in three tributaries; for pool shelter in four tributaries, and for embeddedness in three tributaries. Unsuitable conditions exist for reach in all tributaries evaluated.

Table 20. EMDS anadromous reach condition model results for the Western Subbasin

Stream	Reach	Water Temperature	Canopy	Stream Flow	In Channel	Pool Quality	Pool Depth	Pool Shelter	Embeddedness
Western Subbasin	-	**U**	+	**U**	-	-	-	-	- -
Mill Creek	-	U	++	U	-	- -	- - -	- -	- -
Squaw Creek	-	U	- - -	U	-	-	++	- -	- - -
Honeydew Creek	-	U	-	U	-	-	- -	-	- -
Bear Trap Creek	-	U	-	U	-	-	-	+	- - -
East Fork Honeydew Creek	-	U	+	U	-	-	- - -	+	- -
Upper East Fork Honeydew Creek	-	U	+	U	-	- -	- - -	-	- - -
West Fork Honeydew Creek	-	U	+	U	-	-	- - -	++	-
Bear Creek	-	U	- - -	U	+	++	++	++	+
Jewett Creek	-	U	+++	U	-	- -	- - -	- -	- - -
North Fork Bear Creek	-	U	- -	U	-	-	U	- -	+
North Fork Bear Creek Tributary	-	U	- -	U	-	-	+	- -	+
South Fork Bear Creek	-	U	++	U	-	- -	-	- -	-
Nooning Creek	-	U	++	U	-	- -	- - -	-	- -

Key: +++ Fully Suitable; ++ Moderately Suitable; + Somewhat Suitable; U Undetermined; - - - Fully Unsuitable; - - Moderately Unsuitable; - Somewhat Unsuitable

Analysis of Tributary Recommendations

CDFG inventoried 49.9 miles on 18 tributaries in the Western Subbasin. In Table 21, a CDFG biologist selected and ranked recommendations for each of the inventoried streams, based upon the results of these standard CDFG habitat inventories. More details about the tributary recommendation process are given in the Mattole Synthesis Section of the Watershed Profile.

Table 21. Ranked Tributary Recommendations Summary in the Western Subbasin based on CDFG Stream Inventories.

Stream	# of Surveyed Stream Miles	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Livestock	Fish Passage
Mill Creek (RM 2.8)	1.1	4	3			2	1				
Mill Creek Tributary #1	0.2			2			1				
Mill Creek Tributary #2	0.03			1			2				
Squaw Creek	4.1	3	4	2	1		5				
Woods Creek	1.9	3	4	5		1	2		6		7
Honeydew Creek	4.4	3		5	4	1	2				
Bear Trap Creek	1.9	1	2	6	5	3	4				
Upper North Fork Honeydew Creek	1.0	3		5	4	1	2				6
East Fork Honeydew Creek	2.9	2	5	4	3	1	6				
West Fork Honeydew Creek	0.7	4		5		2	3				1
Bear Creek	7.2	2		1		3	4				
Jewett Creek	2.7	1				4	5		3	2	
North Fork Bear Creek	3.4	5		2	1	6	3		4		
North Fork Bear Creek Tributary #1	1.8	5		2		4	3				1
South Fork Bear Creek	12.0	2				4	1		3		
Big Finley Creek	1.6	3				1	2				
South Fork of Big Finley Creek	1.3					2	1				
Nooning Creek	1.5	1			5	3	2		4		

Temp = summer water temperatures seem to be above optimum for salmon and steelhead; Pool = pools are below target values in quantity and/or quality; Cover = escape cover is below target values; Bank = stream banks are failing and yielding fine sediment into the stream; Roads = fine sediment is entering the stream from the road system; Canopy = shade canopy is below target values; Spawning Gravel = spawning gravel is deficient in quality and/or quantity; LDA = large debris accumulations are retaining large amounts of gravel and could need modification; Livestock = there is evidence that stock is impacting the stream or riparian area and exclusion should be considered; Fish Passage = there are barriers to fish migration in the stream.

In order to further examine Western Subbasin issues through the tributary recommendations given in CDFG stream surveys, the top three ranking recommendations for each tributary were collapsed into five different recommendation categories: Erosion/Sediment, Riparian/Water Temp, Instream Habitat, Gravel/Substrate, and Other (Table 22). When examining recommendation categories by number of tributaries, the most important recommendation category in the Western Subbasin is Instream Habitat.

Table 22. Three ranking recommendation categories by number of tributaries in the Western Subbasin.

West Subbasin Target Issue:	Related Table Categories:	Count:
Erosion / Sediment	Bank / Roads	13
Riparian / Water Temp	Canopy / Temp	9
Instream Habitat	Pool / Cover	24
Gravel / Substrate	Spawning Gravel / LDA	2
Other	Livestock / Barrier	3

However, comparing recommendation categories in the Western Subbasin by number of tributaries could be confounded by the differences in the number of stream miles surveyed on each tributary. Therefore, the number of stream miles in each subbasin assigned to the various recommendation categories was calculated (Figure 11). When examining recommendation categories by number of stream miles, the most important recommendation categories in the Western Subbasin are Instream Habitat, Erosion/Sediment, and Riparian/Water Temperature.

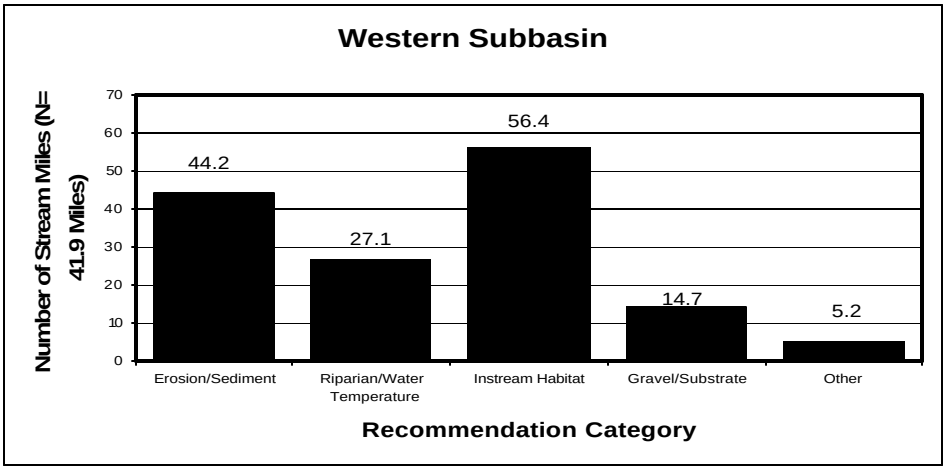

Figure 11. Recommendation categories by stream miles in the Western Subbasin.

The high number of Instream Habitat, Erosion/Sediment Riparian/Water, and Temp Recommendations across the Western Subbasin indicates that high priority should be given to restoration projects emphasizing pools, cover, sediment reduction, and riparian replanting.

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the Western Subbasin by using expert professional judgment and criteria developed for north coast watersheds. The criteria included measures of watershed and stream ecosystem processes, the presence and status of fishery resources, forestry and other land uses, land ownership, potential risk from sediment delivery, water quality, and other factors that may affect refugia productivity. The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales.

The most complete data available in the Western Subbasin were for tributaries surveyed by CDFG. However, many of these tributaries were still lacking data for some factors considered by the team.

Salmonid habitat conditions in the Western Subbasin on surveyed streams are generally rated as medium potential refugia. Bear Creek is the only creek in the Mattole Basin determined to provide high quality refugia. Mill (RM 2.8), North Fork Bear, South Fork Bear, Big Finley, and South Fork Big Finley creeks, and the tributary to North Fork Bear Creek provide high potential refugia in this subbasin, while the remaining surveyed tributaries provide medium quality refugia. The following refugia area rating table summarizes subbasin salmonid refugia conditions:

Table 23. Tributary salmonid refugia area ratings in the Western Subbasin.

Stream	Refugia Categories*:				Other Categories:		
	High Quality	**High Potential**	**Medium Potential**	**Low Quality**	**Non-Anadromous**	**Critical Contributing Area/Function**	**Data Limited**
Mill Creek (RM 2.8)		X					X
Mill Creek (RM 2.8) Tributary #1			X				X
Mill Creek (RM 2.8) Tributary #2			X				X
Squaw Creek			X				X
Woods Creek			X				X
Honeydew Creek			X				X
Bear Trap Creek			X				X
East Fork Honeydew Creek			X				X
Upper East Fork Honeydew Creek			X				X
West Fork Honeydew Creek			X				X
Bear Creek	X						X
Jewett Creek			X				X
North Fork Bear Creek		X					X
North Fork Bear Creek Tributary		X					X
South Fork Bear Creek		X					
Big Finley Creek		X					X
South Fork of Big Finley Creek		X					X
Nooning Creek			X				X
Subbasin Rating			X				

*Ratings in this table are done on a sliding scale from best to worst. See page 61 for a discussion of refugia criteria.

Western Subbasin Profile: Responses to Assessment Question Six:

What watershed and habitat improvement activities would most likely lead toward more desirable conditions in a timely, cost effective manner?

- Based upon the latest science on placement of large woody debris in stream channels, managers in the Western Subbasin should work to improve channel structure and function for salmonids. Pool shelter has the lowest suitability for salmonids in Mill Creek (RM 2.8) Tributary #1 and South Fork Big Finley Creek;
- Establish monitoring stations and train local personnel to track in-channel sediment and aggraded reaches throughout the subbasin and especially in the lower reaches of major tributaries and Squaw, Honeydew, Finley, Big Finley, Woods and Bear creeks;
- Continue efforts such as road improvements and decommissioning throughout the basin to reduce sediment delivery to the Mattole River and its tributaries. Road inventories have been completed for much of this planning basin, and it is recommended that this effort be continued until a complete inventory is compiled. CDFG stream surveys indicated Mill Creek (RM 2.8) and Bear Trap Creek have road sediment inventory and control as a top tier tributary improvement recommendation;
- Monitor summer water and air temperatures to detect trends using continuous 24 hour monitoring thermographs. Continue temperature monitoring efforts in Stansberry, Mill (RM 2.8) Clear, Squaw, Woods, Honeydew, Bear, North Fork Bear, South Fork Bear, Little Finley, Big Finley, and Nooning creeks, and expand efforts into other subbasin tributaries;
- Ensure that near stream forest projects retain and recruit high canopy densities in riparian areas to reduce solar radiation and moderate air temperatures;

- Where current canopy is inadequate and site conditions, including geology, are appropriate, use tree planting and other vegetation management techniques to hasten the development of denser and more extensive riparian canopy. Canopy density has the lowest suitability for salmonids in Squaw Creek. Use cost share programs and conservation easements as appropriate;
- The three cooperative salmon rearing facilities in this subbasin should be continued as needed to supplement wild populations while the improvements from long-term watershed and stream restoration efforts develop;
- Initiate a systematic program to monitor the effectiveness of these fish rescue and rearing activities, and determine the need for the continuance of cooperative, supplemental fish rearing efforts on an ongoing, adaptive basis using the best available science;
- The nature and extent of naturally occurring unstable geologic terrain, landslides and landslide potential (especially Categories 4 and 5) must be considered when planning potential projects in the subbasin;
- Encourage the use of appropriate Best Management Practices for all land use and development to minimize erosion and sediment delivery to streams;
- In order to protect privacy on private lands in this subbasin while developing data, the possibility of training local landowners to survey streams and conduct salmonid population status surveys is advisable;
- Ensure that high quality habitat within this subbasin is protected from degradation. The highest stream reach condition as evaluated by the stream reach EMDS and refugia analysis were found in Bear, Mill (RM 2.8), North Fork Bear, South Fork Bear, Big Finley, and South Fork Big Finley creeks and the tributary to North Fork Bear Creek.

Subbasin Conclusions

Although having some of the steepest slopes in the Mattole Basin, the Western Subbasin is underlain by predominately hard terrain and is second only to the Southern Subbasin in terms of stable areas. Conversely, there is a preponderance of instream and near-stream features impacting subbasin streams that are very similar to the Eastern Subbasin. High sedimentation level, high summer water temperatures, and a lack of suitable spawning gravel may be limiting salmonid populations in many streams. Available data suggest instream habitat complexity may be adequate or recovering but that LWD recruitment potential from riparian sources is limited. However, historical accounts indicate that salmonid populations and stream complexity were much more favorable in the past. The continuation of present salmonid rearing activities to supplement wild populations is further encouraged. The management by BLM of publicly owned lands in the King Range National Conservation Area, particularly in the headwater reaches of larger streams such as Honeydew, Bear, and Squaw creeks as late seral reserve, should help further the recover process in this subbasin. The enlistment of cooperative landowners in key headwater reaches to further implement beneficial land use practices will also assist watershed recovery efforts. Conditions beneficial to salmonids may be further enhanced in this subbasin through encouraging all motivated subbasin landowners to use good land stewardship practices and enlisting the aid and support of agency technology, experience, and funding opportunities is encouraged.

Mattole Basin in the Regional Context

Introduction

Within the context of the North Coast, the Mattole River basin is unique in many ways. The basin receives some of the highest annual rainfall in California. This region also experiences a very high level of seismic activity. Bedrock underlying much of the basin has been tectonically broken and sheared making it relatively weak, easily weathered, and inherently susceptible to landsliding and erosion. The unstable bedrock and soil conditions combined with heavy rainfall, high regional uplift rates, and very active seismicity produce widespread naturally occurring landsliding with associated large volumes of sediment delivered to streams.

The total Mattole Basin resident population for the year 2000 census was approximately 1,200 people. Both Honeydew and Petrolia are two hours driving time south of Eureka, the closest urbanized area. This remoteness has made local residents self-sufficient, independent, and adaptive. Additionally, many local residents have a strong sense of place. Both historic and current land uses are based upon agriculture and forestry. Specific land uses today are centered on relatively small, private non-industrial timber management, cattle and sheep ranching activities, and other agricultural pursuits like orchards, pasture, and field crops.

Fishery resources of the Mattole Basin include fall-run Chinook salmon, coho salmon, summer-run steelhead trout, and winter-run steelhead trout. The salmon and steelhead trout have been traditionally important as food and recreation resources to local residents and visitors.

Based upon commonality of watershed attributes, four subbasins can be distinguished within the context of the Mattole Basin. For the purpose of watershed assessment, these study areas were named the Northern, Eastern, Southern, and Western subbasins. These are in addition to the Estuary, which is a product of the upstream subbasins, but is itself unique. In general, each of the five is somewhat unique from the others, but each has distinguishing attributes that are generally common within the several CalWater 2.2a Planning Watersheds (PW's) contained within the subbasin. The subbasin is a useful assessment scale upon which to conduct analyses of findings, form conclusions, and suggest improvement recommendations.

Summary of Subbasin Conditions and Recommendations

Based on six assessment questions, salmonid habitat in the Mattole Basin was found to have medium to high potential to serve as refugia for salmon and steelhead trout (Table 24).

Table 24. Subbasin Salmonid Refugia Area Ratings in the Mattole Basin.

Subbasin	Refugia Categories:				Other Categories:		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area/Function	Data Limited
Estuary Subbasin			X			X	X
Northern Subbasin			X				X
Eastern Subbasin			X				X
Southern Subbasin		X					X
Western Subbasin			X				X

Salmonid Populations

The assessment of salmonid populations found that:

- The Mattole Basin historically supported relatively robust populations of Chinook salmon, coho salmon, and steelhead trout;
- Recent biological stream surveys indicate the presence of Chinook salmon and steelhead trout in all five Mattole subbasins and the presence of coho salmon in the Eastern, Southern, and Western subbasins;
- No studies have been conducted to estimate subbasin or tributary specific population abundance levels of coho salmon or Chinook salmon; however, a nine-year intensive study of three tributaries within the Northern Subbasin indicated stable age classes of steelhead trout;
- Intensive studies of the Estuary Subbasin have shown depressed populations and poor survival of over-summering Chinook salmon and steelhead trout, and no coho have been detected;
- Mattole basin-wide population estimates indicate depressed metapopulations of Chinook and coho salmon.

Salmonid Habitat

- Instream sedimentation in several stream reaches throughout the basin may be approaching or exceeding levels considered suitable for salmonid populations. Currently, the estuary is very shallow and lacks channel complexity. Conditions in the estuary are thought to be deleterious to salmon and steelhead trout at this time. Erosion/sediment reduction is the top recommendation category for the Eastern and Estuary subbasins;
- High summer water temperatures in many surveyed tributaries are deleterious to summer rearing salmonid populations in the Estuary, Northern, Eastern, and Western subbasins. Riparian/water temperature improvements is the top recommendation category in the Northern Subbasin;
- In general, pool habitat, escape and ambush cover, and water depth are unsuitable for salmonids in many mainstem and tributary stream reaches in the Mattole Basin. In the Southern Subbasin summer flow is inadequate or non-existent in many reaches. Large woody debris recruitment potential is poor in the Northern, Eastern, and Western Subbasins. Instream habitat improvement is the top recommendation category in the Southern and Western subbasins;
- Available data from sampled streams suggest that suitable, high quality spawning gravel for salmonids is limited in some streams in all subbasins;
- Salmonid habitat conditions in the Mattole Basin are generally best in the Southern and Western subbasins, mixed in the Eastern subbasin, and most impacted in the Estuary and Northern subbasins.

Table 25. Summary of Mattole Subbasins Stream and Watershed Conditions and Recommended Action.

	Estuary Subbasin	Northern Subbasin	Eastern Subbasin	Southern Subbasin	Western Subbasin
Identified Conditions					
In-Stream Sediment	**-/R**	**-/R**	-	**-/R**	-
Water Temperature	-	-	~	+	~
Pools	-	-	-	~	-
Flow	+	~	~	-	~
Escape Cover	-	-	-	-	-
Fish Passage Barriers	+	~	~	~	~
Natural Sediment Sources	-	-	~	+	+
Management-Related Sediment Sources	-	-	+	-	+
Recommended Improvement Activity Focus Areas					
Flow				**X**	
Erosion/Sediment		**X**	**X**	**X**	**X**
Riparian/Water Temperature	**X**	**X**	**X**		**X**
Instream Habitat	**X**	**X**	**X**	**X**	**X**
Gravel/Substrate			**X**	**X**	**X**
Fish Passage Barriers				**X**	**X**

\+ Condition is favorable for anadromous salmonids
\- Condition is not favorable for anadromous salmonids
~ Condition is mixed or indeterminate for anadromous salmonids
R Trend indicates improved conditions 1984-2000
X Recommended improvement activity focus areas

Geology

The assessment of geology found that:

- Geologic units within the basin can be grouped into one of three bedrock terrains (hard, moderate, and soft) and one for Quaternary alluvial units. Larger landslides are more prevalent in soft terrain and are typically earthflows, while smaller slides, typically debris slides, are more prevalent in hard and moderate terrains;
- Weak geologic materials, steep slopes, high rainfall, and strong earthquakes common to the basin result in high rates of natural landsliding and surface erosion, particularly in soft terrain. These natural processes can be exacerbated by human land use within the basin. About one half of the basin is considered to have a high to very high landslide potential;
- In general, the subbasins can be ranked in terms of relative impacts with geologically unstable areas linked to adverse stream effects. The Northern Subbasin has the largest proportion of geologically unstable (soft) terrain, which is linked to the highest amount of historically active landslides, gullies, and stream features indicative of excess sediment production, transport and storage. The Southern Subbasin has the lowest proportion of geologically unstable terrain, historically active landslides, gullies, and stream features indicative of excess sediment production and transport. The Eastern and Western subbasins are intermediate between these two extremes due to the variability in the proportion of soft terrain and steep slopes;
- Source and transport reaches of the blue line streams as depicted on stream network maps, were identified primarily in bedrock terrains, while response (depositional) reaches were identified in the Quaternary (alluvial) unit reaches. Features indicative of excess sediment production, transport and storage have decreased throughout most of the basin

in the period between 1984 and 2000. The reduction in these features was greatest in the hard terrain. The distribution of these features in bedrock terrains suggests that portions of the areas interpreted as having a high to very high landslide potential are also the sources of sediment that has been delivered to streams;

- Human activities such as timberland conversion to grasslands and brush, grazing, timber harvest, and road construction and use, have interacted with natural geologic instability to increase sediment production far above naturally high background levels.

Vegetation

The assessment of vegetation found that:

- Historic timber harvesting and streamside road construction reduced riparian canopy and increased direct sediment inputs and water temperature. Overall, the current landscape is comprised of smaller diameter forest stands than in pre-European times;
- There has been little timber harvesting in the Mattole Basin in the last decade, and it is not likely under current management that intense timber harvest will occur;
- Remaining stands in late seral reserve are fragmented in the basin, and found largely on the public land in the Western and Eastern subbasins;
- A considerable part of the Southern Subbasin is now in State Park or Sanctuary Forest management, and no commercial harvest is planned in the subbasin;
- Large woody debris recruitment potential is currently limited by the low percentage of near-stream forest stands containing trees in large diameter classes, but the situation should improve with the current forest management scenario;
- Decades of fire suppression have created dense forest stands and brush-lands leading to the designation of Mattole Basin population centers as high wildfire threat areas.

Land Use Impacts

The assessment of land use found that:

- Land use, including road construction and use, timber harvesting, and grazing, has added excess sediment to the fluvial system. Many of the effects from these activities are spatially and temporally removed from their upland sources. Excess sediment remains in the Mattole mainstem despite decades of low timber harvesting activity;
- Currently, roads are a major land use contributor of sediment (CDF, 2002). Large storms or other catastrophic events combined with poor road location and construction practices have the potential to deliver large and adverse amounts of sediment into stream systems;
- Water extraction for agriculture, road maintenance, and residential use has the direct effect of reducing the amount of available habitat for fish;
- Grazing is widespread on privately owned grasslands and has shifted to cattle since the enactment of predation protection measures. Stock impacts to streams are not common or widespread, but watercourse exclusionary fencing is limited.

Limiting Factors Analysis General Conclusions

Based on available information for the Mattole Basin, the team believes that salmonid populations in general are currently being affected in various locations in the basin by:

- Impacted estuarine conditions;
- General lack of habitat complexity in many stream reaches;
- High instream sediment levels;
- High summer water temperatures;
- Inadequate flows during summer low flow periods;
- Reduced basin-wide coho and Chinook metapopulations.

Summarized Recommendations:

Flow and Water Quality Improvement Activities:

- Discourage unnecessary and wasteful use of water during summer low flow periods to improve stream surface flows and fish habitat, especially in the Southern Subbasin;
- Increase the use of water storage and catchments systems that collect rainwater in the winter for use in the drier summer season;
- Support local efforts to educate landowners about water storage and catchments systems, and find ways to support and subsidize development of these systems;
- Support and expand ongoing local efforts that monitor summer water and air temperatures on a continuous 24-hour basis to detect long-range trends and short-term effects on the aquatic/riparian community;
- Support the Mattole Salmon Group's efforts to determine the role of sediment in the mainstem Mattole River in elevated estuarine water temperatures.

Erosion and Sediment Delivery Reduction Activities:

- Reduce sediment deposition to the estuary by supporting a basin-wide road and erosion assessment/control program such as the Mattole Restoration Council's *Good Roads, Clear Creeks* effort. Continue to conduct and implement road and erosion assessments such as the on-going efforts in the Dry and Westlund planning watersheds in the Eastern Subbasin. Expand road assessment efforts because of the potential for further sediment delivery from active and abandoned roads, many of which are in close proximity to stream channels in the Bridge and Thompson planning watersheds in the Southern Subbasin;
- Establish monitoring stations and train local personnel to track in-channel sediment and aggraded reaches throughout the basin and especially in the North Fork Mattole and the Upper North Fork Mattole rivers, Mattole Canyon, Blue Slide, Squaw, Honeydew, and Bear creeks;
- Consider the nature and extent of naturally occurring unstable geologic terrain, landslides and landslide potential (especially Categories 4 and 5) when planning potential projects in the subbasin;
- At stream bank erosion sites, encourage cooperative efforts to reduce sediment yield to streams. CGS mapping indicates eroding banks are not a significant basin wide issue, but may be of localized importance. They occur in isolated, relatively short reaches distributed throughout the Mattole Basin;
- Based on the high incidence of unstable slopes in the Northern Subbasin, any future sub-division development proposals should be based on an existing county-imposed forty acre minimum parcel sub-division ordinances;
- Encourage the use of appropriate Best Management Practices for all land use and development activities to minimize erosion and sediment delivery to streams. For example, low impact yarding systems should be used in timber harvest operations on steep and unstable slopes to reduce soil compaction, surface disturbance, and resultant sediment yield.

Riparian and Habitat Improvement Activities:

- Where current canopy is inadequate and site conditions, including geology, are appropriate, initiate tree planting and other vegetation management to hasten the development of denser and more extensive riparian canopy, especially in the Northern Subbasin;
- Landowners and managers in the Northern and Western subbasins should work to add more large organic debris and shelter structures to streams in order to improve channel structure, channel function, habitat complexity, and habitat diversity for salmonids;

- Ensure that stream reaches with high quality habitat in the Mattole Basin are protected from degradation. This is especially important in the Southern Subbasin. The best stream conditions as evaluated by the stream reach EMDS were found in the South Fork of Vanauken Creek, Mill Creek - at Mattole river-mile 56.2 (RM 56.2), Stanley Creek, Thompson Creek, Yew Creek, and Lost Man Creek Tributary in the Southern Subbasin, and in Harrow Creek in the Eastern Subbasin. Refugia investigation criteria, which include biological parameters, indicated Bear Creek was the best stream evaluated in the Mattole Basin.

***Supplemental Fish Rescue and Rearing Activities**:*

- Since 1982 a successful cooperative salmonid rearing facility in the Mattole headwaters has been operated by the Mattole Salmon Group (MSG) and CDFG. They also operate a Chinook juvenile out-migrant rescue rearing program near the estuary, which released 2,400 coded-wire-tagged Chinook sub-yearlings in October 2002. These programs should be continued as needed to supplement wild populations while the improvements from long-term watershed and stream restoration efforts develop;
- Initiate a systematic program to monitor the effectiveness of fish rescue and rearing activities, and determine the need for the continuance of cooperative, supplemental fish rearing efforts;
- Update as scheduled the MSG / CDFG five-year plan that provides guidance to the cooperative rearing and rescue projects. Base the periodic plan updates on the findings of the effectiveness monitoring program and best available science.

Education, Research and Monitoring Activities:

- Utilize Humboldt State University studies conducted in the early 1990s as baseline information to periodically monitor trends in estuarine conditions and fish production;
- Encourage ongoing stream inventories and fishery surveys of tributaries throughout the Mattole Basin, especially in the Northern Subbasin;
- In order to protect privacy while developing data, the possibility of training local landowners to survey their own streams and to conduct salmonid population status surveys throughout the basin would be advisable;
- Further study to investigate the affects to water quality from timberland herbicide use is recommended;
- Follow the procedures and guidelines outlined by NCRWQCB to protect water quality from ground applications of pesticides;
- Encourage appropriate chemical transportation and storage practices as well as early spill reportin g and clean-up procedures;
- Conduct training as needed and desired to assist landowners, managers, consultants, and other interested parties in the construction and appropriate application of landslide occurrence and potential maps from GIS analysis.

Propensity for Improvement

Advantages

The Mattole Basin has several advantages for planning and implementing successful salmonid habitat improvement activities that include:

- An active restoration community made up of many highly skilled and experienced individuals. This community includes the comprehensive Mattole River and Range Partnership. The Partnership is composed of several natural resources agencies, Mattole landowners, and watershed groups like the Mattole Salmon Group and the Mattole Restoration Council. This broad base provides a common forum for different points of view and interests concerning the watershed and fisheries within the basin;

- Skilled fundraisers who are capable of recruiting funds from a myriad of grant programs. Currently, a major grant was secured by members of the Partnership from the Coastal Conservancy for a multi-year general watershed improvement program which includes various activities ranging from education to stream work;
- A skilled workforce with a core of experienced workers. This group of community based technicians provides a resource for ensuring successful projects and building future technical capacity in the basin. The logical long range product of this component is better watershed stewardship on a landscape scale;
- An expanding group of cooperative landowners that includes both public and private landowners from all subbasins in the Mattole. The effect of this growing cooperative land-base is the ability to choose locations for projects where the best result can be achieved in the shortest period of time. This accelerates the overall effectiveness of the watershed improvement program. The current Good Roads, Clear Creeks program is an example of this advantage;
- Several watersheds and streams are now well into recovery and should respond well to continued stewardship and improvement treatments.
- This assessment containing findings, conclusions, and recommendations for improvement opportunities. This report provides focus from the basin scale, through the subbasin scale and down to the level of specific tributary assessments. With this tool to focus project design efforts, local landowners and restoration groups can pursue the mutual development of site specific improvement projects on an adaptive basis;
- A core population of Chinook salmon, coho salmon, and steelhead trout as well as summer steelhead unique to the Mattole River system. Although depressed from historic levels there remain local stocks that can take advantage of improved conditions. Over time, barring overwhelming outside impacts, the stocks should grow in response to watershed efforts. Currently, efforts by the Cooperative Hatchbox and Rescue Rearing Program are augmenting these core populations.

Challenges

The Mattole Basin also has some challenges confronting efforts to improve watershed and fish habitat conditions, and increase anadromous fish populations:

- Not all landowners are interested in salmonid habitat improvement efforts. Without a watershed wide cooperative land-base, treatment options are limited. In some cases this can remove some key areas from consideration of project development;
- High natural erosion rates will always be a part of the Mattole landscape. These high background erosion thresholds makes the need to reduce human induced erosion rates to as close to zero as possible an imperative;
- Summer and early fall water resources are very limited in some very important parts of the basin, particularly the Southern Subbasin. The very good instream habitat conditions in that subbasin are of no use to fish without water in the streams. As human water use intensifies, the loss of critical fish stocks will continue and compromise other fishery improvement efforts.
- The risk of pollutant spills also becomes problematic with increases in near stream residential and agricultural development and occupation.
- Even if needed watershed improvement efforts succeed in reducing sediment yield to basin streams, the estuary will be slow respond. The scale of the problem and the nature of low gradient, depositional reaches to move sediment slowly cause this situation. Therefore, containing the erosion that exceeds natural background levels will affect estuarine habitat improvements only over a very long period of time. That means basin wide sediment reduction efforts will have to be sustained with a great deal of patience for a very long time, in fact, in perpetuity. Meanwhile, salmonid stocks impacted by the

harsh estuarine conditions will have to be protected and perhaps rescued until conditions improve. Fish rescue is a very difficult and risky task and can be problematic itself.

- Chinook and coho salmon and summer steelhead metapopulations are currently reduced to levels that could impact the amount of needed straying of colonizing fish into improved or expanded habitat conditions. Without a high degree of habitat seeding from strays, metapopulation increases are compromised and the desired response to improvement efforts are slowed, successes masked, and evaluation difficult.

Conclusion

The likelihood that any North Coast basin will react in a responsive manner to management improvements and restoration efforts is a function of existing watershed conditions. In addition, the status of processes influencing watershed conditions will affect the success of watershed improvement activities. A good knowledge base of these current watershed conditions and processes is essential for successful watershed improvement. Acquiring this knowledge requires property access. Access is also needed to design, implement, monitor, and evaluate suitable improvement projects. This systematic process is dependent upon the cooperative attitude of resource agencies, watershed groups and individuals, and landowners and managers.

The Mattole assessment has considered a great deal of available information regarding watershed conditions and processes in the Mattole Basin. This long assessment and analysis has identified problems and made recommendations to address these problems while considering the advantages and challenges of conducting watershed improvement programs in the Mattole Basin.

After considering these problems, recommendations, advantages and challenges, the Mattole Basin appears to be a very good candidate for a successful long term programmatic watershed improvement effort. According to the current refugia analysis, the Mattole Basin has medium to high potential to become a high quality refugia habitat basin. Reaching this goal is dependent upon the formation of a well organized and thoughtful improvement program founded on a broad based community commitment to active watershed stewardship. The energy and opportunity appears to be present here, and well underway in many parts of the basin. If these efforts are pursued vigorously and patiently, one day the Mattole could once again be known as “clear waters” and be home to both a healthy fishery resource and a healthy watershed-based community in a uniquely diverse and beautiful area.

Tributary Recommendations Analysis

The California Department of Fish and Game (CDFG) inventoried 59 tributaries to the Mattole River and the headwaters of the Mattole from 1991 to 2002 using protocols in the *California Salmonid Stream Habitat Restoration Manual*. The tributaries and the headwaters of the Mattole River surveyed were composed of 93 stream reaches, defined as Rosgen channel types. The stream inventories are a combination of several stream reach surveys: habitat typing, channel typing, biological assessments, and in some reaches LWD and riparian zone recruitment assessments. An experienced biologist and/or habitat specialist conducted QA/QC on field crews and collected data, performed data analysis, and determined general areas of habitat deficiency based upon the analysis and synthesis of information.

The CDFG biologist selected and ranked recommendations for each of the inventoried streams, based upon the results of these standard CDFG habitat inventories, and updated the recommendations with the results of the stream reach condition EMDS and the refugia analysis (Table 26). It is important to understand that these selections are made from stream reach conditions that were observed at the times of the surveys and do not include upslope watershed observations other than those that could be made from the streambed. They also reflect a single point in time and do not anticipate future conditions. However, these general recommendation categories have proven to be useful as the basis for specific project development, and provide focus for on-the-ground project design and implementation. Bear in mind that stream and watershed conditions change over time and periodic survey updates and field verification are necessary if watershed improvement projects are being considered.

Table 26. List of tributary recommendations in stream tributary reports

Recommendation	Explanation
Temp	Summer Water Temperatures Were Measured To Be Above Optimum For Salmon And Steelhead
Pool	Pools Are Below Target Values In Quantity And/Or Quality
Cover	Escape Cover Is Below Target Values
Bank	Stream Banks Are Failing And Yielding Fine Sediment Into The Stream
Roads	Fine Sediment Is Entering The Stream From The Road System
Canopy	Shade Canopy Is Below Target Values
Spawning Gravel	Spawning Gravel Is Deficient In Quality And/Or Quantity
LDA	Large Debris Accumulations Are Retaining Large Amounts Of Gravel And Could Need Modification
Livestock	There Is Evidence That Stock Is Impacting The Stream Or Riparian Area And Exclusion Should Be Considered
Fish Passage	There Are Barriers To Fish Migration In The Stream

In general, the recommendations that involve erosion and sediment reduction by treating roads and failing stream banks, and riparian and near stream vegetation improvements precede the instream recommendations in reaches that demonstrate disturbance levels associated with watersheds in current stress. Instream improvement recommendations are usually a high priority in streams that reflect watersheds in recovery or good health. Various project treatment recommendations can be made concurrently if watershed and stream conditions warrant.

Fish passage problems, especially in situations where favorable stream habitat reaches are being separated by a man-caused feature (e.g., culvert), are usually a treatment priority. Good examples of these are the recent and dramatically successful Humboldt County/CDFG culvert replacement projects in tributaries to Humboldt Bay. In these regards, more general watershed scale upslope assessments can go a long way in helping determine the suitability of conducting instream improvements based upon watershed health. As such, there is an important relationship between the instream and upslope assessments.

Additional considerations must enter into the decision process before these general recommendations are further developed into improvement activities. In addition to watershed

condition considerations as a context for these recommendations, there are certain logistic considerations that enter into a recommendation's subsequent ranking for project development. These can include work party access limitations based upon lack of private party trespass permission and/or physically difficult or impossible locations of the candidate work sites. Biological considerations are made based upon the propensity for benefit to multiple or single fishery stocks or species. Cost benefit and project feasibility are also factors in project selection for design and development.

Potential Salmonid Refugia

Establishment and maintenance of salmonid refugia areas containing high quality habitat and sustaining fish populations are activities vital to the conservation of our anadromous salmonid resources (Moyle and Yoshiyama 1992; Liet al. 1995; Reeves et al. 1995). Protecting these areas will prevent the loss of the remaining high quality salmon habitat and salmonid populations. Therefore, a refugia investigation project should focus on identifying areas found to have high salmonid productivity and diversity. Identified areas should then be carefully managed for the following benefits:

- Protection of refugia areas to avoid loss of the last best salmon habitat and populations. The focus should be on protection for areas with high productivity and diversity;
- Refugia area populations which may provide a source for re-colonization of salmonids in nearby watersheds that have experienced local extinctions, or are at risk of local extinction due to small populations;
- Refugia areas provide a hedge against the difficulty in restoring extensive, degraded habitat and recovering imperiled populations in a timely manner (Kaufmann, et al. 1997).

The concept of refugia is based on the premise that patches of aquatic habitat provide habitat that still retain the natural capacity and ecologic functions that support wild anadromous salmonids in such vital activities as spawning and rearing. Anadromous salmonids exhibit typical features of patchy populations; they exist in dynamic environments and have developed various dispersal strategies including juvenile movements, adult straying, and relative high fecundity for an animal that exhibits some degree of parental care through nest building (Reeves et al. 1995). Conservation of patchy populations requires conservation of several suitable habitat patches and maintaining passage corridors between them.

Potential refugia may exist in areas where the surrounding landscape is marginally suitable for salmonid production or altered to a point that stocks have shown dramatic population declines in traditional salmonid streams. If altered streams or watersheds recover their historic natural productivity, either through restoration efforts or natural processes, the abundant source populations from nearby refugia can potentially re-colonize these areas or help sustain existing salmonid populations in marginal habitat. Protection of refugia areas is noted as an essential component of conservation efforts to ensure long-term survival of viable stocks, and a critical element towards recovery of depressed populations (Sedell, 1990; Moyle and Yoshiyama 1992; Frissell 1993, 2000).

Refugia habitat elements include the following:

- Areas that provide shelter or protection during times of danger or distress;
- Locations and areas of high quality habitat that support populations limited to fragments of their former geographic range; and
- A center from which dispersion may take place to re-colonize areas after a watershed and/or sub-watershed level disturbance event and readjustment.

Spatial and Temporal Scales of Refugia

These refugia concepts become more complex in the context of the wide range of spatial and temporal habitat required for viable salmonid populations. Habitat can provide refuge at many scales from a single fish to groups of them, and finally to breeding populations. For example, refugia habitat may range from a piece of wood that provides instream shelter for a single fish, or

individual pools that provide cool water for several rearing juveniles during hot summer months, to watersheds where conditions support sustaining populations of salmonid species. Refugia also include areas where critical life stage functions such as migrations and spawning occur. Although fragmented areas of suitable habitat are important, their connectivity is necessary to sustain the fisheries. Today, watershed scale refugia are needed to recover and sustain aquatic species (Moyle and Sato 1991). For the purpose of this discussion, refugia are considered at the fish bearing tributary and subbasin scales. These scales of refugia are generally more resilient than the smaller, habitat unit level scale to the deleterious effects of landscape and riverine disturbances such as large floods, persistent droughts, and human activities (Sidell et al. 1990).

Standards for refugia conditions are based on reference curves from the literature and CDFG data collection at the regional scale. The assessment team uses these values in its EMDS models and stream inventory, improvement recommendation process. Li et al. (1995) suggested three prioritized steps to use the refugia concept to conserve salmonid resources.

- Identify salmonid refugia and ensure they are protected;
- Identify potential habitats that can be rehabilitated quickly;
- Determine how to connect dispersal corridors to patches of adequate habitat.

Refugia and Metapopulation Concept

The concept of anadromous salmonid metapopulations is important when discussing refugia. The classic metapopulation model proposed by Levins (1969) assumes the environment is divided into discrete patches of suitable habitat. These patches include streams or stream reaches that are inhabited by different breeding populations or sub-populations (Barnhart 1994,; McElhany et al. 2000). A metapopulation consists of a group of sub-populations which are geographically located such that over time, there is likely genetic exchange between the sub-populations (Barnhart 1994). Metapopulations are characterized by 1) relatively isolated, segregated breeding populations in a patchy environment that are connected to some degree by migration between them, and 2) a dynamic relationship between extinction and re-colonization of habitat patches.

Anadromous salmonids fit nicely into the sub-population and metapopulation concept because they exhibit a strong homing behavior to natal streams forming sub-populations, and also have a tendency to stray into new areas. The straying or movement into nearby areas results in genetic exchange between sub-populations or seeding of other areas where populations are at low levels. This seeding comes from abundant or source populations supported by high quality habitat patches which may be considered as refugia.

Habitat patches differ in suitability and population strength. In addition to the classic metapopulation model, other theoretical types of spatially structured populations have been proposed (Li et al. 1995; McElhany et al. 2000). For example, the core and satellite (Li et al. 1995) or island-mainland population (McElhany et al. 2000) model depicts a core or mainland population from which dispersal to satellites or islands results in smaller surrounding populations. Most straying occurs from the core or mainland to the satellites or islands. Satellite or island populations are more prone to extinction than the core or mainland populations (Li et al. 1995; McElhany et al. 2000). Another model termed source-sink populations is similar to the core-satellite or mainland-island models, but straying is one way, only from the highly productive source towards the sink subpopulations. Sink populations are not self-sustaining and are highly dependant on migrants from the source population to survive (McElhany et al. 2000). Sink populations may inhabit typically marginal or unsuitable habitat, but when environmental conditions strongly favor salmonid production, sink population areas may serve as important sites to buffer populations from disturbance events (Li et al. 1995) and increase basin population strength. In addition to testing new areas for potential suitable habitat, the source-sink strategy adds to the diversity of behavior patterns salmonids have adapted to maintain or expand into a dynamic aquatic environment.

The metapopulation and other spatially structured population models are important to consider when identifying refugia because in dynamic habitats, the location of suitable habitat changes (McElhany et al. 2000) over the long term from natural disturbance regimes (Reeves et al. 1995)

and over the short term by human activities. Satellite, island, and sink populations need to be considered in the refugia selection process because they are an integral component of the metapopulation concept. They also may become the source population or refugia areas of the future.

Methods to Identify Refugia

Currently there is no established methodology to designate refugia habitat for California's anadromous salmonids. This is mainly due to a lack of sufficient data describing fish populations, metapopulations and habitat conditions and productivity across large areas. This lack of information holds true for basins especially in terms of metapopulation dynamics. Studies are needed to determine population growth rates and straying rates of salmonid populations and sub-populations to better utilize spatial population structure to identify refugia habitat.

Classification systems, sets of criteria and rating systems have been proposed to help identify refugia type habitat in north coast streams, particularly in Oregon and Washington (Moyle and Yoshiyama 1992; FEMAT 1993; Li et al. 1995; Frissell et al. 2000; Kisup County, 2000). Upon review of these works, several common themes emerge. A main theme is that refugia are not limited to areas of pristine habitat. While ecologically intact areas serve as dispersal centers for stock maintenance and potential recovery of depressed sub-populations, lower quality habitat areas also play important roles in long-term salmonid metapopulation maintenance. These areas may be considered the islands, satellites, or sinks in the metapopulation concept. With implementation of ecosystem management strategies aimed at maintaining or restoring natural processes, some of these areas may improve in habitat quality, show an increase in fish numbers, and add to the metapopulation strength.

A second common theme is that over time within the landscape mosaic of habitat patches, good habitat areas will suffer impacts and become less productive, and wink out and other areas will recover and wink in. These processes can occur through either human caused or natural disturbances or succession to new ecological states. Regardless, it is important that a balance be maintained in this alternating, patchwork dynamic to ensure that adequate good quality habitat is available for viable anadromous salmonid populations (Reeves et al. 1995.)

Assessment Team Approach to Identifying Refugia

The interdisciplinary team identified and characterized refugia habitat by using expert professional judgment and criteria developed for North Coast watersheds. The criteria used considered different values of watershed and stream ecosystem processes, the presence and status of fishery resources, forestry and other land uses, land ownership, potential risk from sediment delivery, water quality, and other factors that may affect refugia productivity. The expert refugia team encouraged other specialists with local knowledge to participate in the refugia identification and categorization process.

The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales. Stream reach and watershed parameter evaluation scores were used to rank stream and watershed conditions based on collected field data and air photo analysis. Stream reach scale parameters included pool shelter rating, pool depth, embeddedness, and canopy cover. Water temperature data were also used when available. The individual parameter scores identified which habitat factors currently support or limit fish production (see EMDS and limiting factors sections).

Planning watershed scale parameters used are road density, number of stream crossings, road proximity to streams, riparian cover, and LWD loading potential. The refugia team used the potential sediment production and other planning watershed scale EMDS evaluations in a similar manner as they became available.

When identifying anadromous salmonid refugia, the team took into account that anadromous salmon have several non-substitutable habitat needs for their life-cycle. A minimal list (NMFS 2000) includes:

- Adult migration pathways;
- Spawning and incubation habitat;
- Stream rearing habitat;
- Forage and migration pathways;
- Estuarine habitat.

The best refugia areas are large and meet all of these life history needs and therefore provide complete functionality to salmonid populations. These large, intact systems are scarce today and smaller refugia areas that provide for only some of the requirements have become very important areas, but cannot sustain large numbers of fish. These must operate in concert with other fragmented habitat areas for life history support and refugia connectivity becomes very important for success. Therefore, the refugia team considers relatively small, tributary areas in terms of their ability to provide at least partial refuge values, yet contribute to the aggregated refugia of larger scale areas. Therefore, the team's analyses use the tributary scale as the fundamental refugia unit.

The team created a tributary scale refugia-rating worksheet (CDFG Appendix F). The worksheet has 21 condition factors that were rated on a sliding scale from high quality to low quality. The 21 factors were grouped into five categories:

- Stream condition;
- Riparian condition;
- Native salmonid status;
- Present salmonid abundance;
- Management impacts (disturbance impacts to terrain, vegetation, and the biologic community).

Tributary ratings were determined by combining the results of air photo analyses results, EMDS results, and data in the CDFG tributary reports by a multi-disciplinary, expert team of analysts. The various factors' ratings were combined to determine an overall tributary rating on a scale from high to low quality refugia. Tributary ratings were subsequently aggregated at the subbasin scale and expressed a general estimate of subbasin refugia conditions. Factors with limited or missing data were noted. In most cases there were data limitations on 1 – 3 factors. These were identified for further investigation and inclusion in future analysis.

The assessment team has created a hierarchy of refugia categories that contain several general habitat conditions. This descriptive system is used to rank areas by applying results of the analyses of stream and watershed conditions described above and are used to determine the ecological integrity of the study area. A basic definition of biotic integrity is "the ability [of an ecosystem] to support and maintain a balanced, integrated, and functional organization comparable to that of the natural habitat of the region" (Karr and Dudley 1981).

The Report of the Panel on the Ecological Integrity of Canada's National Parks submitted this definition:

The Panel proposes the following definition of ecological integrity: "An ecosystem has integrity when it is deemed characteristic for its natural region, including the composition and abundance of native species and biological communities, rates of change and supporting processes. "In plain language, ecosystems have integrity when they have their native components (plants, animals and other organisms) and processes (such as growth and reproduction) intact.

Assessment Team Salmonid Refugia Categories and Criteria:

High Quality Habitat, High Quality Refugia

- Maintains a high level of watershed ecological integrity (Frissell 2000);
- Contains the range and variability of environmental conditions necessary to maintain community and species diversity and supports natural salmonid production (Moyle and Yoshiyama 1992; Frissell 2000);

- Relatively undisturbed and intact riparian corridor;
- All age classes of historically native salmonids present in good numbers, and a viable population of an ESA listed salmonid species is supported (Li et al. 1995);
- Provides population seed sources for dispersion, gene flow and re-colonization of nearby habitats from straying local salmonids;
- Contains a high degree of protection from degradation of its native components.

High Potential Refugia

- Watershed ecological integrity is diminished but remains good (Frissell 2000);
- Instream habitat quality remains suitable for salmonid production and is in the early stages of recovery from past disturbance;
- Riparian corridor is disturbed, but remains in fair to good condition;
- All age classes of historically native salmonids are present including ESA listed species, although in diminished numbers;
- Salmonid populations are reduced from historic levels, but still are likely to provide straying individuals to neighboring streams;
- Currently is managed to protect natural resources and has resilience to degradation, which demonstrates a strong potential to become high quality refugia (Moyle and Yoshiyama 1992; Frissell 2000).

Medium Potential Refugia

- Watershed ecological integrity is degraded or fragmented (Frissell, 2000);
- Components of instream habitat are degraded, but support some salmonid production;
- Riparian corridor components are somewhat disturbed and in degraded condition;
- Native anadromous salmonids are present, but in low densities; some life stages or year classes are missing or only occasionally represented;
- Relative low numbers of salmonids make significant straying unlikely;
- Current management or recent natural events have caused impacts, but if positive change in either or both occurs, responsive habitat improvements should occur.

Low Quality Habitat, Low Potential Refugia

- Watershed ecological integrity is impaired (Frissell, 2000);
- Most components of instream habitat are highly impaired;
- Riparian corridor components are degraded;
- Salmonids are poorly represented at all life stages and year classes, but especially in older year classes;
- Low numbers of salmonids make significant straying very unlikely;
- Current management and / or natural events have significantly altered the naturally functioning ecosystem and major changes in either of both are needed to improve conditions.

Other Related Refugia Component Categories:

Potential Future Refugia (Non-Anadromous)

- Areas where habitat quality remains high but does not currently support anadromous salmonid populations;
- An area of high habitat quality, but anadromous fish passage is blocked by man made obstructions such as dams or poorly designed culverts at stream crossings etc.

Critical Contributing Areas

- Area contributes a critical ecological function needed by salmonids such as providing a migration corridor, conveying spawning gravels, or supplying high quality water (Li et al. 1995)
- Riparian areas, floodplains, and wetlands that are directly linked to streams (Huntington and Frissell 1997).

Data Limited

Areas with insufficient data describing fish populations, habitat condition watershed conditions, or management practices.

Steps to Identifying Refugia:

The interdisciplinary team identifies and characterizes refugia habitat by using expert professional judgment and criteria developed for North Coast watersheds. The criteria include the status of extant fishery populations and stream and watershed conditions affecting them. The team also considers the status and trends in processes delivering watershed products including the transport and routing of water, sediment, wood, nutrients, and heat through the system. Thus, the level of natural and land use disturbances – past, present, and future – are considered as well. This process provides insights concerning current watershed conditions, processes, and trends. It also projects likely outcomes for refugia status in the future.

Step One: A refugia rating team is established. The team includes the interdisciplinary assessment team plus local landowners or other experts.

Step Two: The team meets in an expert session to consider:
Ecological Management Decision Support system outputs and LFA conclusions based on stream reach scale. EMDS parameters include pool shelter rating, pool depth, embeddedness, and canopy cover. LFA parameters include these and others like flow, water quality, fish passage, etc.
EMDS Planning Watershed scale parameters for road density, number of stream crossings, road proximity to streams, riparian cover, and LWD loading potential. These parameters are used to estimate watershed process disturbance levels and risk to streams. The Basin Assessment Report's Integrated Analysis process is applied to each subbasin in the assessment area. These analyses consider the status and linkages between geology, vegetation history, land use, water quality, fluvial geo-morphology, stream habitat, and fishery status at the subbasin scale. Systematic, stratified, random samples of streams are also used within the subbasin units. These samples have only been used in one subbasin to date, but they provide the information to estimate the conditions on several stream parameters (Gallo, 2001). Local information provided by landowners and others well acquainted with the subject area.

Step Three: The refugia rating team uses the foregoing information to rate several fish, stream, and watershed components on a rating worksheet. Initially, team members complete the sections of the worksheet independently in the area of their expertise.

Step Four: The team collectively reviews the several independent ratings to validate the overall collective rating. The results of the tributary rating sheets are then collapsed into a rating for the Planning Watershed and subbasin scales within the basin context. Regional inter-basin comparisons can be made when the collection of large scale basin assessments is more complete.

CDFG Refugia Worksheet
The assessment team created a worksheet for rating refugia at the tributary scale (See Table 27). The worksheet has 21 condition factors rated on a sliding scale from high to low quality. The 21 factors are grouped into five categories: 1) stream condition; 2) riparian condition; 3) native

salmonid status; 4) present salmonid abundance; and 5) management impacts (disturbance impacts to terrain, vegetation, and the biologic community). The tributary ratings are determined by combining the results of aerial photo analyses, EMDS, and data in the CDFG tributary reports by a multi-disciplinary, team of expert analysts. Ratings of various factors are combined to determine an overall refugia rating on a scale from high to low quality. The tributary ratings are subsequently aggregated at the subbasin scale and expressed as a general estimate of subbasin refugia conditions. Factors with limited or missing data are noted and discussed in the comments section as needed. In most cases there are data limitations on one to three factors. These are identified for further investigation and analysis.

The rating sheet is used by placing an "X" on a sliding scale extending from High Quality to Low Quality in each row of the rating sheet. The comments section can be used to explain items like missing data, or special situations like diversions or dams, etc.

After the sheets are completed, the ratings in each section are averaged as are the five sections' mean ratings to produce an overall summary rating for the sub-watershed (stream). These stream ratings are then normalized by stream distance and/or sub-watershed area and once more combined to produce a mean refugia rating useful for comparison between subbasins.

Although the range of variance within these layers is somewhat blurred through this lumping procedure, particulars and detail can be regained by focusing back down through the layers from subbasin to sub-watershed, stream, and finally to the individual parameters. In this manner guidance can be given to an analyst investigating opportunities for watershed improvements through restoration or management activities.

Table 27. Refugia Rating Worksheet

Stream Name:			**Date:**
Raters:			
Ecological Integrity - Overall Refugia Summary Ratings:	High Quality; High Potential; Medium Potential; Low Quality (Other: *Non-Anadromous; Contributing Functions; Data Limited*)		
Stream Condition:	**High Quality**	**Medium Quality**	**Low Quality**
Stream Flow			
Water Temperature			
Free Passage			
Gravel			
Pools			
Shelter			
In-Channel Large Wood			
Canopy			
Nutrients			
Stream Summary Rating:			
Riparian Condition:	**High Quality**	**Medium Quality**	**Low Quality**
Forest Corridor Seral Stage			
Fluvial Dis-equilibrium			
Aquatic/Riparian Community			
Riparian Summary Rating:			
Native Salmonids Status: (Native Species and Age Classes)	**Present**	**Diminished**	**Absent**
Chinook			
Coho			
Steelhead			
Species Summary Rating:			
Salmonid Abundance:	**High**	**Medium**	**Low**
Chinook			
Coho			
Steelhead			
Abundance Summary Rating:			
Management Impacts:	**Low Impacts**	**Medium Impacts**	**High Impacts**
Disturbed Terrain			
Displaced Vegetation			
Native Biologic Integrity			
Impacts Summary Rating:			
Comments:			

Limitations of this Assessment

This watershed assessment provides useful and valuable information and represents a considerable effort of the involved agencies, contractors, and public. It was limited in duration, scope, detail, and analysis level due to constraints in budget, time, access, and overall resources. Where data are limited, hypotheses were developed to test or improve our understanding of watershed processes. Specific limitations are presented below to put the assessment in context.

- Point or more local data, e.g., individual stream reaches, were described in relation to those smaller geographical areas. As descriptions and inferences are drawn from those data to a more regional, watershed scale, the certainty associated with those conclusions and inferences is reduced.
- The CGS's landslide and geomorphic analyses were limited to aerial photo interpretation from varying sets of photos and limited verification. Limited aerial photo coverage does not bracket temporal distribution of important watershed events, which may not be evident in photos taken years after the fact.
- Imagery from 1965 was only partly reviewed. Due to access, time, budget, and staffing constraints, field checking of interpretations did not occur.
- The geologic analysis did not identify erosion sources beyond mass wasting and gullying, such as surface erosion or erosion induced by human activities.
- At the analysis scale of 1:24,000, the detection of geologic features smaller than 100 feet in greatest diameter is poor.
- Localized point source channel aggradation and meandering flows observed shortly after the 1964 storms were not systematically compared sequentially through time to detail evolving stream channel morphology.
- The CGS's channel classification was done based on channel gradients taken from a Digital Elevation Model. This model was based on imperfect topographic data. Most of the basin topography is mapped at a contour interval of 80 feet, which is too coarse to adequately interpret the gradient of individual reaches. No field stream gradient surveys were done for this assessment, due to time and budget constraints.
- The CGS analysis of fluvial and hillslope conditions has not been completed. Collected data are not completely converted into a digital format needed for spatial analysis. This includes the CGS's Landslide Potential Map, fluvial geomorphic characteristics, and spatial data from NCRWQCB, CDFG, DWR, and CDF. The CGS has not reviewed all documents referenced in this report.
- There was only time to compare broad contrasts between land use impacts and habitat conditions.
- The NCRWQCB's water chemistry analysis was limited to available USEPA StoRet data for the period 1973 to 1988 at one location, and samples obtained by the NCRWQCB at four locations for two sampling events in 2001. The sampling frequency was scattered and discontinuous and did not allow for much detailed temporal analysis.
- Data on pesticide occurrences in surface water were not available from StoRet, private interests, nor collected in the NCRWQCB sampling of 2001.
- The temperature range used for proposed fully suitable of 50-60° F was developed as an average of the needs of several cold water fish species and life stages, including Chinook and coho salmon, and steelhead and cutthroat trout. As such, the range does not represent the slight variance of fully acceptable ranges for particular species.
- In-channel data and some temperature data were provided as summary statistics (medians, means, and maxima), limiting the ability to factor variability into the analysis,

and not allowing for independent checks on the data quality. As such, the analyses and subsequent assessment are limited in scope.

- Temperature data analysis did not include probability of exceedance from cumulative distribution plots, or hours of exceedance of a threshold. This analysis was limited by not having raw data for all sites, obtaining raw data late in the analysis, and data interface problems.
- The NCRWQCB did not have acceptably useful turbidity or suspended solids data, though they are considered crucial to watershed analysis. The absence of useful data and any analysis of suspended loads and turbidity are limitations in this assessment. These data sets exist, but were for one surface sampling location only and were not used in the 2002 assessment.
- Analysis of temperature information is without knowledge of the extent of a thermal reach upstream of the continuous data logger.
- Historic timber harvesting data are compiled from previous work performed by the Mattole Restoration Council. The CDF has not yet validated the accuracy of this data.
- Although the CDFG has surveyed just over 130 miles of anadromous reaches in the Mattole Basin, there are a few, most importantly Mattole Canyon Creek and unsurveyed reaches of the North Fork Mattole River, which could possibly identify opportunities for local improvements for fish. Extensive stream surveys will strengthen the stewardship effort.
- Most CDFG surveys used for this stream reach assessment were conducted in the mid 1990's. A few surveys are more recent, while three are nearly ten years old. Although most channel characteristics remain relatively constant, components like habitat complexity and riparian shade canopy can change fairly quickly. Current surveys would contribute to data relevance and help track change to the streams in a timelier manner.
- The EMDS model used is preliminary; not all components of the model are currently in use due to data and modeling issues (i.e., stream temperature, fish passage, stream flow); not all data layers used in the model have yet been fully subjected to quality control review; scientist and practitioner peer review of the model is planned but not yet completed.